Lau's observations on relative abundance of *P. phrictus* indicate that this species may constitute a significant portion of the demersal fish biomass in the area of the Bering Sea where he sampled. During a sampling period from 12 to 31 July, 76 hauls were taken, of which 38 were subsampled. *Psychrolutes phrictus* was present in subsamples from 9 of these 38 hauls and ranked 6 of 44 species found, based on weight. When individuals were present in subsamples of the catch, they represented 0.3-8.2% of the subsample weight (Table 1) and 1.8% of the overall subsample weight for the sampling period. Individuals were also observed casually in hauls where they were not part of the subsample.

The capture of two juveniles off the Oregon coast about 2,500 m above the bottom and about 65 km west of the lower continental slope is evidence that the larvae and juveniles are pelagic. Whether juveniles normally occur so far offshore, and if so, whether such individuals survive to reach the bottom, is not known. *Psychrolutes phrictus* probably leaves the pelagic zone and becomes demersal at about 30 mm. The rationale for this is that the juveniles (28 and 30 mm) reported here were pelagic, whereas those (30 and 49 mm) reported by Stein and Bond (1978) were benthic.

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A RECURRENT MASS STRANDING OF THE FALSE KILLER WHALE, *PSEUDORCA CRASSIDENS*, IN FLORIDA

The false killer whale, *Pseudorca crassidens*, is one of the several species of odontocetes known primarily through its relatively frequent mass strandings. These strandings offer a large amount of natural history data but, in most cases, investigators have been unable, for various reasons, to thoroughly study these events. As a result, very few data are available on the natural history of *P. crassidens* (Mitchell 1975a, b; Purves and Pilleri 1978). *Pseudorca crassidens* is distributed worldwide in temperate and tropical waters (Mitchell 1975b), and frequently strands in large numbers (Norman and Fraser 1948; Dudok van Heel 1962), exceeding 800 in one case (Marelli 1953; Tomilin 1957; Reiger 1975). The series of *P. crassidens* mass strandings we describe herein is the third in Florida in recent years. Caldwell et al. (1970) reported a stranding of 150-175 false killer whales near Ft. Pierce on the Atlantic coast of Florida in January 1970. Little data was collected and most of the animals were apparently buried on the beach. A heretofore unreported stranding occurred on 18-19 July 1972 on the northeast end of Sawyer Key (lat. 24°45.6′ N, long. 81°33.4′ W) in the lower Florida Keys on the Florida Bay (Gulf of Mexico) side. This site is approximately 35 km northeast of Key West (Figure 1). Nineteen animals were involved. Gordon Hubbell[1] estimated the largest animals to be 460 cm (15 ft) long. He measured a 320 cm (10.5 ft) male, a 376 cm (10.3 ft) female, and a 427 cm (14.0 ft) female.

Sequence of Events

1. The Florida Marine Patrol[2] reported a whale stranding near North Captiva Island on the southwest coast of Florida (Figure 1) on the morning of 22 July 1976. We found a dead 440 cm female false killer whale at Redfish Pass (Figure 2) and four live females aground on a sandbar in Pine Island Sound (Figure 2). We necropsied the dead animal on the beach and transported the live animals to Sea World, Orlando, Fla., on 22 July. At least 29 false killer whales had entered Pine Island Sound: 1 died; 4 were stranded alive; 24

[1]Gordon Hubbell, Director, Crandon Park Zoo, Miami, Fla. 33149, pers. commun. 1977.

[2]Florida Marine Patrol, Officer in Charge, Ft. Myers Office, pers. commun. July 1976.

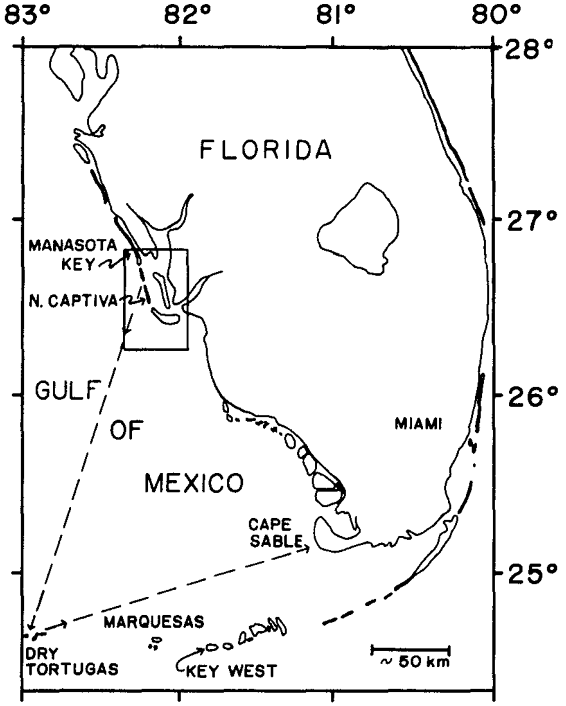

FIGURE 1.—Outline map of south Florida indicating principal stranding sites and possible routes of travel of the false killer whale herd. Fort Pierce is located just north of lat. 27° N on the east coast of the state. Box represents region covered by succeeding figure.

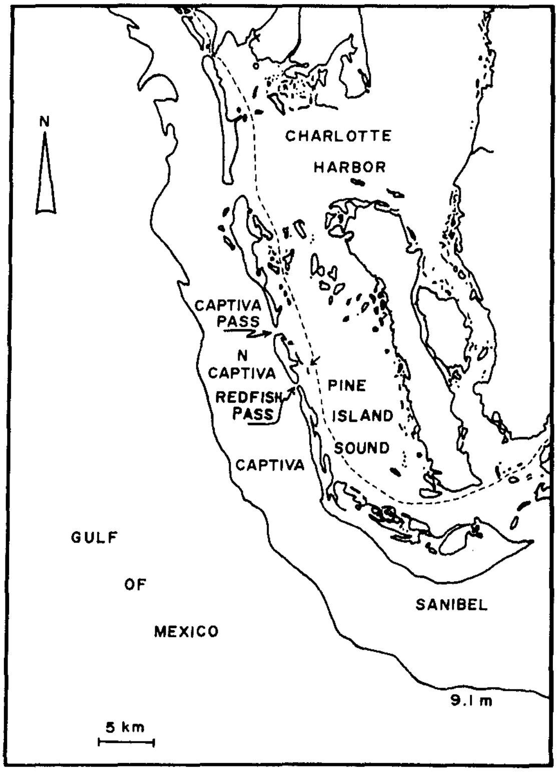

FIGURE 2.—North Captiva Island and vicinity, south Florida, indicating Redfish Pass and Captiva Pass where the false killer whales entered and exited Pine Island Sound. The four females taken to Sea World stranded on a sand bar located off the southeast side of North Captiva (indicated by an arrow). Intracoastal waterway is indicated by dashed line in Charlotte Harbor and Pine Island Sound.

were photographed exiting Captiva Pass (Larson[3]). All moved northward in or near the Intracoastal Waterway after entering Pine Island Sound via Redfish Pass. They continued northward and returned to the Gulf of Mexico via Captiva Pass (Florida Marine Patrol see footnote 2; Larson see footnote 3) (Figure 2). The animals originally entered Redfish Pass at about 0830 h. The tide was rising and near the high point (Florida Marine Patrol see footnote 2). The exact time, and thus tidal conditions when the animals exited Captiva Pass are unknown to us. It is interesting to note that a spinner dolphin, *Stenella longirostris*, herd stranded on Casey Key (lat. 27°12′10″ N, long. 82°30′30″ W) 7 days earlier (Mead et al.[4]). This site is about 75 km north of North Captiva.

2. A herd of 30 false killer whales stranded on Loggerhead Key, Dry Tortugas (Figure 1), at approximately 1300 h on 25 July on a falling tide. This site is some 235 km south of North Captiva Island. The herd was divided into two groups at the time of stranding (Shinn[5]). The animals were pushed back into the water and kept wet by U.S. Coast Guard and National Park Service personnel. We measured and sexed the animals and photographed their dorsal fins and flukes for individual identification of the animals on 26 July. We repeated the measurements and photographs, collected blood samples and marked each animal with a spaghetti tag (Floy Tag FD-68B[6] anchor

[3]Peter Larson, *Sanibel Island Reporter*, Sanibel, Fla., pers. commun. 1976.

[4]Mead, J. G., D. K. Odell, R. S. Wells, and M. Scott. 1978. Biological observations on a mass stranding of spinner dolphins (*Stenella longirostris*) from the west coast of Florida. Unpubl. manuscr. Division of Mammals, Smithsonian Institution, Washington, DC 20560.

[5]Eugene Shinn, U.S. Geological Survey, Miami, Fla., pers. commun. 1976.

[6]Floy Tag & Manufacturing Inc., Seattle, Wash. Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

tag) on 27 July. A 520 cm male died prior to an attempt to return all of the animals to offshore waters. A group effort by Park Service, Florida Marine Patrol, Coast Guard, and other personnel successfully forced the remaining 29 out to sea. Color photographs and a popular description of this stranding are given by Porter (1977).

3. On 2 August, National Park Service personnel found three shark-eaten *P. crassidens* carcasses floating about 2 km off Cape Sable (Figure 1). They towed these to shore and Odell examined them on 3 August.

4. On 23 August, Odell salvaged 20 *P. crassidens* skulls from carcasses discovered on Cape Sable by the National Park Service on 18 August. The whales were severely decomposed when first discovered and had probably been on the beach for at least 2 wk. Sex determination and external measurements were not possible (Odell and Asper[7]; Odell et al.[8]).

Results and Discussion

We measured 29 of the 30 whales that stranded on Loggerhead Key (total length only). The mean length (±SD) of 12 males was 458±48 cm, range 377-534 cm and 17 females was 416±39 cm, range 328-494 cm. The mean lengths were significantly different at the 0.01 level. The weight-length data (250 kg, 297 cm; 327 kg, 338 cm; 359 kg, 358 cm; 773 kg, 475 cm) from the four live females that we collected at North Captiva Island yielded the following predictive allometric equation corrected for log transformation bias (Beauchamp and Olson 1973): $W = 2.16 \times 10^{-4} L^{2.437}$, where W is weight in kilograms and L is length in centimeters.

The length exponent in the above equation is low when compared with similar equations for several other marine mammals. Bryden (1972) summarized the weight-length relationships for a number of marine mammals. The length exponents for several cetaceans are: *Delphinapterus leucas*—two populations, males, 2.536 and 2.605 (Sergeant and Brodie 1969); *Globicephala melaena*—2.895; *Balaenoptera musculus*—3.25 (Ash 1952); *B. physalus*—2.9 (Ash 1952); *B. borealis*—two populations, 2.43 and 2.74 (Omura 1950; Fujino 1955); and *Megaptera novaeangliae*—3.1 (Ash 1953). The mean (±SD) of these eight length exponents is 2.807±0.283. The relatively low length exponent for *P. crassidens* could be due to the small sample size or perhaps to poor condition of the animals, since we do not know how long the animals had been without food before stranding. However, the 95% confidence limits on the *P. crassidens* length exponent are 2.437±0.564.

The necropsies of six (four captive, two in field) recently decreased whales indicated extensive parasitism. Most apparent in all animals were hundreds (perhaps thousands) of the acanthocephalan worm, *Bolbosoma capitatum*, attached to the walls of the small intestine (Overstreet[9]). We found pieces of intestine with attached acanthocephalans near the Cape Sable animals. Five of the six animals had hundreds of the nematode, *Stenurus globicephalus*, in the pterygoid sinus complex. Three animals had the stomach nematode, *Anisakis* cf. *simplex* (Overstreet see footnote 9). Four animals had *S. globicephalus* in the lungs (Overstreet see footnote 9). Notable was the apparent absence in all six animals of cestode plerocercoid cysts in the blubber. Histopathology revealed that the ultimate cause of death of the four captive females was primarily pneumonia with some parasitic involvement.[10] The pathological condition(s) that led to pneumonia remain speculative. Hall and Schimpff[11, 12] examined the brains of the captive animals and of the male that died on Loggerhead Key and found them free of major neurologic disease, although they stated that some animals exhibited "behavioral symptoms suggestive of

[7]Odell, D., and E. Asper. 1977. A summary of information derived from a mass stranding of *P. crassidens* in Florida, 1976. (Abstr.) Marine Mammal Stranding Workshop, Athens, Ga., 10-12 August, 1977, p. 20-21. U.S. Marine Mammal Commission contract MM7AC020.

[8]Odell, D. K., E. D. Asper, J. Baucom, and L. H. Cornell. 1979. A summary of information derived from the recurrent mass stranding of a herd of false killer whales, *Pseudorca crassidens* (Cetacea: Delphinidae). *In* J. R. Geraci and D. J. St. Aubin (editors), Biology of marine mammals: insights through strandings, p. 207-222. Final Rep., U.S. Marine Mammal Commission contract MM7AC020. Available Natl. Tech. Inf. Serv., Springfield, Va., as PB 293380.

[9]Robin Overstreet, Gulf Coast Research Laboratory, Ocean Springs, MS 39564, pers. commun. September 1976.

[10]Armed Forces Institute of Pathology, Washington, DC 20306, cases 1579706 and 1579707, pers. commun. October 1976.

[11]Hall, N. R., and R. D. Schimpff. 1977. Neuropathology in relation to stranding. 2. Mass stranded whales. (Abstr.) Marine Mammal Stranding Workshop, Athens, Ga., 10-12 August 1977, p. 28-29. U.S. Marine Mammal Commission contract MM7AC020.

[12]Hall, N. R., and R. D. Schimpff. 1979. Neuropathology in relation to strandings: mass strandings. *In* J. R. Geraci and D. J. St. Aubin (editors), Biology of marine mammals: insights through strandings, p. 236-242. Final Rep., U.S. Marine Mammal Commission, contract MM7AC020. Available Natl. Tech. Inf. Serv., Springfield, Va., as PB 293380.

vestibular dysfunction." They also found no parasitic infiltration of the eighth cranial nerves or the vestibular cochlear nuclei.

We examined the reproductive organs from the six fresh carcasses. We judged the male to be sexually mature on the basis of body length (520 cm), total testis weight (8,200 g) and histological demonstration of spermatogenesis. We considered three of the females (body lengths 297, 338, 358 cm) sexually immature. Neither corpora lutea nor corpora albicantia were found in the ovaries (Harrison[13]) and ovary weight was low (13.3, 14.0, and 15.1 g, respectively) compared with the other two females. One female (475 cm) had three corpora albicantia in the left ovary and five to six corpora albicantia in the right ovary (Harrison see footnote 13). Ovary weight was 46.8 g. We also considered the 440 cm female from Redfish Pass to be sexually mature based on ovary weight (65 g) and the presence of three corpora albicantia in the left ovary and six in the right.

Few data are available on sexual maturity and reproduction in *P. crassidens*. Comrie and Adams (1938) examined four 425-450 cm female specimens of *P. crassidens* that were all sexually mature. Norman and Fraser (1948) and Purves and Pilleri (1978) stated that sexual maturity was reached in both sexes at 366-427 cm (12-14 ft) long. Using Norman and Fraser's length range, three females from the Tortugas stranding would be considered immature with the lower limit and nine with the upper limit, and three males would be considered immature with the upper limit.

Hematology

We took blood from vessels in the flukes, flippers, or dorsal fins. Samples for cell counts and hemoglobin determinations were collected in anticoagulant tubes. We collected sera from separate tubes after the blood had clotted, and stored it frozen until it was analyzed. Cell counts were done with a Coulter Model D-2 (Coulter Electronics, Hialeah, Fla.). Serum chemistry analyses were done with a Clinicard Model 368 (Harleco Div. American Hospital Supply Co., Gibbstown, N.J.). This is one of the few (if not the only) times when blood samples have been collected from an entire herd of stranded cetaceans. The data from the 30 Loggerhead Key animals are similar to hematologic values for other small cetaceans (Table 1; Ridgway et al. 1970; Ridgway 1972). Brown et al. (1966) gave some data on blood cell counts from the one false killer whale held at Marineland of the Pacific for 7 yr. Those values are roughly similar to those presented here, but red cell counts were higher (4.5-5.2 $\times$ 10^6/mm^3). The blood values for our four female false killer whales (Table 1) vary somewhat from the Loggerhead Key group and undoubtedly reflect their deteriorating condition. Notable are leucocytosis with an eosinophilia in both groups (Table 1). Serum calcium levels were elevated when compared with other odontocetes. Lactic acid dehydrogenase levels were slightly elevated. All of the above conditions can be indicative of heat stress, parasitism, pneumonia, etc. in other odontocetes, and we assume that *P. crassidens* responds similarly. Alkaline phosphatase levels were low, indicating depletion of reserves. This depletion generally signals impending death in other odontocetes. Blood urea nitrogen and glucose levels were higher in the captives than in the Loggerhead Key animals and could reflect the fact that captives were feeding while the other group had probably not fed for several days. White blood cell counts and lactic acid dehydrogenase levels were the only parameters in which males and females differed significantly (t-test, 0.01 level).

Behavior in Captivity

The four live false killer whales transported to Sea World appeared to adapt to captivity with relative ease. When first put into their pool, they began to swim rapidly around the pool as a group, swimming in a clockwise direction with the largest animal (475 cm), apparently leading the group. They often took food from the hand and were not easily disturbed by routine handling for physical examinations. Within 24 h after their arrival, the largest and the smallest whales were separated from the other two and placed in an adjacent pool. The overall swimming patterns of all the animals remained the same after the separation. However, their swimming pace slowed considerably. The general behavior and apparent rapid adaptation to captivity was quite similar to that observed in a captive false killer whale (animal collected at sea) held at Marineland of the Pacific (Brown et al. 1966).

All of the animals began feeding on mackerel and herring immediately upon arrival. The 338

[13]Richard J. Harrison, Anatomy School, Cambridge University, Cambridge, Engl., pers. commun. 1976.

TABLE 1.—Blood chemistry analyses from two groups of the false killer whale, *Pseudorca crassidens*, stranded in Florida compared with data for the bottlenose dolphin, *Tursiops truncatus*, and the Pacific whitesided dolphin, *Lagenorhynchus obliquidens*.

Parameter	*P. crassidens*[1]			*P. crassidens*[2]			*T. truncatus*[3]		*L. obliquidens*[3]	
	[4]*N*	$\bar{x}$	SD	*N*	$\bar{x}$	SD	*N*	$\bar{x}$	*N*	$\bar{x}$
Hemoglobin (g/100 ml)	26	15.95	0.84	23	14.27**	1.29	296	14.73*	67	18.61*
Hematocrit (%)	26	46.04	2.05	23	41.26**	3.22	345	44.04*	79	51.67*
Red cell count (10^6/mm^3)	26	4.01	0.27	23	3.80**	0.29	291	4.05*	64	5.56*
Mean corpuscular hemoglobin (pg)	26	39.85	2.04	23	37.53**	2.28	—	[5]36.37	—	[5]33.47
Mean corpuscular volume μ^3	26	115.02	4.61	23	108.70**	6.47	—	[5]108.74	—	[5]92.93
Mean corpuscular hemoglobin conc. (g/dl)	26	34.64	0.95	23	34.56	1.53	—	[5]33.45	—	[5]36.02
White cell count (10^3/mm^3):										
Females	15	7,324*	1,765	23	8,842	3,434	167	9,780*	31	6,668*
Males	11	5,922*	1,203	—	—	—	154	10,675*	41	7,922*
Differential white cell count:										
Bands (immatures) (%)	26	1.31	2.02	23	1.83	2.21	318	1	72	1
Neutrophils (%)	26	73.31	12.43	23	71.83	10.82	318	61	72	42
Lymphocytes (%)	26	13.50	6.59	23	16.96	7.30	318	21	72	29
Eosinophils (%)	26	13.38	9.65	23	9.17	7.65	318	14*	72	22
Monocytes (%)	26	0.58	0.86	23	0.43	0.73	318	3	72	5
Basophils(%)	26	0	0	23	0	0	—	—	—	—
Blood urea nitrogen (mg/100 ml)	29	24.40	4.91	20	46.40**	14.82	232	51*	62	37
Calcium (mg/100 ml)	29	10.67	2.01	17	8.67**	0.56	166	10	29	10
Creatinine phosphokinase (IU/liter)	28	22.93	16.09	13	86.77**	134.82	—	—	—	—
Total cholesterol (mg/100 ml)	29	218.17	47.30	20	305.00**	87.38	301	221	92	154
Lactic acid dehydrogenase (IU/liter)										
Females	17	566.24	80.65	17	364.65**	76.52	100	113	11	179
Males	12	508.83	56.83	—	—	—	80	130	18	244
Alkaline phosphatase (IU/liter)	29	98.72	56.51	20	149.15**	113.80	71	241*	6	256*
Serum glutamic oxaloacetic transaminase (IU/liter)	29	217.52	88.46	20	382.15**	166.82	172	98*	34	110*
Serum glutamic pyruvic transaminase (IU/liter)	29	43.03	63.58	20	31.89**	28.43	88	19	14	45
Glucose (mg/100 ml)	29	80.76	28.76	20	167.10**	52.34	231	129	52	117
Total protein (g/100 ml)	29	7.60	0.56	20	7.32	0.85	133	8.0	10	9.0
Albumin (g/100 ml)	29	3.55	0.34	20	3.71	0.40	109	3.4	10	3.9
Globulin (g/100 ml)	29	3.91	0.73	20	3.55	0.75	—	—	—	—

[1]Animals from Loggerhead Key; each animal sampled once.
[2]The four females held at Sea World; each animal sampled several times.
[3]Data from Ridgway et al. (1970).
[4]Number of determinations made.
[5]Values calculated using mean values for hematocrit, hemoglobin and red cell count.
*Significant difference between males and females, *t*-test, 0.01 level.

cm female consumed an average (±SD) of 20±7.6 kg of mackerel and herring/day, in a ratio of 1.5:1, from 25 July through 9 August. Food consumption decreased significantly on 10 August and the animal died on 13 August. Similarly, the 297 cm female consumed 15.3±4.0 kg of mackerel and herring (2.2:1) between 24 July and 3 August. Food consumption dropped to 1.8 kg on 4 August, rose to 18.6 kg on 8 August when smelt was added to the diet, and then decreased to 5.4 kg on 13 August. Overall food consumption between 24 July and 13 August was 11.7±5.7 kg/day. The animal died on 14 August. The 358 cm female consumed 15.1±8.5 kg of mackerel and herring/day (1.2:1) between 24 July and 7 August. Food consumption decreased on 4 August and remained stable through 7 August ($\bar{x}$ = 9.0±2.5 kg/day). Consumption between 24 July and 3 August was 17.1±8.9 kg/day. Smelt was introduced on 8 August in place of mackerel and total consumption was 22.7 kg. Squid was also added on 9 August. The animal died on 10 August. The 475 cm female had an erratic food consumption (mackerel and herring, 19.4±16.2 kg/day) between 24 July and 29 July when it died. The individual blood chemistry analyses for these four animals reflected their deteriorating condition (Odell et al. see footnote 8) and their combined values were significantly different from the Loggerhead Key animals (Table 1).

Relationships Among Strandings

It is clear, based on photographs, that some of the false killer whales that left Pine Island Sound were the same individuals that stranded on Loggerhead Key. Low altitude (helicopter) aerial photographs were taken of the animals leaving Captiva Pass (Larson see footnote 3). Comparison of these photographs with photographs of dorsal fins of the Tortugas animals provided positive identification of several individuals. Dorsal fin shapes have been used to identify specific individual dolphins over periods of several months

(Würsig and Würsig 1977). Assuming that the animals left Captiva Pass at about 1200 h on July 22, and that they travelled in a straight line, they had to travel about 80 km/day to reach Loggerhead Key at 1300 h on 25 July. When these animals were escorted away from Loggerhead Key on 27 July, they apparently headed northeast (Schimpff[14]). The dead animals we found on Cape Sable were too decomposed to tell if they were the Captiva-Tortugas animals. Three large black whales were seen by a National Park Service pilot several kilometers east of the Dry Tortugas when the other animals were stranded. These may be the first three animals found floating off Cape Sable on 2 August by Park Service personnel, but the evidence is only circumstantial.

The sequence of strandings described herein roughly parallels a series of pilot whale, *Globicephala macrorhynchus*, strandings that occurred in the same vicinity on 19-20 August 1971 (Fehring and Wells 1976). Forty-four pilot whales stranded on Manasota Key and on Gasparilla Island a few kilometers to the south (Figure 1). On 25 August 1971, 12 or 13 pilot whales were found stranded on the Marquesas Keys east of Key West (Figure 1). At least one of these was positively identified to be from the previous stranding.

Fehring and Wells (1976) reported that the pilot whales observed stranding on Gasparilla Island made "a deliberate shoreward movement" as opposed to "disoriented panic." Eugene Shinn (see footnote 5) unknowingly photographed the false killer whales minutes before they beached on Loggerhead Key while taking aerial photographs of the reef formations. The photographs show two close-knit pods of whales heading towards the beach. Fehring and Wells also reported that the behavior of the stranded animals changed after the two largest pilot whales were towed offshore and held there with ropes around their caudal peduncles. The remainder of the animals then showed less tendency to return to shore when pushed off. Several of the larger Loggerhead Key whales were forced offshore (headfirst, without ropes around their tails) in hope that the others would follow. The animals herded offshore returned to the beach when released. The operation was only successful when all of the animals were forced offshore simultaneously and herded to deeper water, using swimmers and two boats. While on the Loggerhead Key beach, the whales were docile, as Fehring and Wells (1976) reported for the pilot whales. Coast Guard personnel who followed the animals offshore reported that the herd split into two groups (one of 17-18 and one of 10 or 11 animals) (Schimpff see footnote 14).

[14]Robert Schimpff, Department of Pathology, College of Medicine, University of Florida, Gainesville, FL 32610, pers. commun. 1977.

Conclusions

From the veterinary medical standpoint, we would doubt the ability of those animals that were necropsied to function normally with the heavy parasite load in the pterygoid sinus complexes. The benefits of forcing live stranded animals back out to sea must be carefully weighed against the benefits of bringing them into captivity, where they can be observed closely and thoroughly necropsied should death occur. If stranded whales are returned to sea, they should be given permanent, individual identification marks (e.g., freeze brands) and, ideally, outfitted for radio tracking.

Acknowledgments

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OCCURRENCE OF THE FINETOOTH SHARK, *CARCHARHINUS ISODON*, OFF DAUPHIN ISLAND, ALABAMA[1]

Carcharhinus isodon (Valenciennes) is an infrequently encountered species with a poorly known life history. The literature on this species covering the western North Atlantic contains much information on juveniles, but very little on adults. All lengths discussed herein are total lengths.

Radcliffe (1916) reported a single specimen 50.8 cm in the Bureau of Fisheries collection at Beaufort, N.C. Burton's (1940) record of an immature male, 74.4 cm, was the first from South Carolina waters. Specimens examined by Bigelow and Schroeder (1948:304-308) ranged from 46 to 56.7 cm. Springer (1950) examined 20 adult females 147-155 cm collected in December off Salerno, Fla. Thirteen had from one to six embryos 43-48 cm; the remaining seven had enlarged flaccid uteri and medium-sized ovarian

[1]Contribution No. 028, Dauphin Island Sea Lab.