GEOGRAPHIC VARIATION OF THE PARASITES CRASSICAUDA (NEMATODA) AND PHYLLOBOTHRIUM (CESTODA) IN PHOCOENOIDES DALLI IN THE NORTHERN NORTH PACIFIC AND BERING SEA

by

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INTRODUCTION

The use of parasites as natural biological tags for stock identification and migration pattern studies has been successful in fishes (Mackenzie, 1978; Sindermann, 1961; Margolis, 1963) and invertebrates (Gaevskaya and Nigmatullin, 1975; 1981; Naidenova, 1978). Delyamure (1955) investigated geographic variation in parasite composition of marine mammal populations on a world wide basis. Recent studies in the eastern North Pacific have demonstrated the usefulness of parasites in stock identification of small cetaceans (Walker, 1981; Dailey and Otto, 1982; Walker et al., 1984).

This study surveys and compares the incidence of the spiruroid nematode, Crassicauda sp. and the larval cestode, Phyllobothrium sp. in Dall's porpoise, Phocoenoides dalli collected in the offshore waters of the northern North Pacific and Bering Sea.

Members of the genus Crassicauda infect a wide variety of cetacean hosts (Dailey and Brownell, 1972). The number of valid species in the genus remains unclear. Skrjabin (1969) lists 13 species, however, few entire worms had been examined due to the extensive tissue involvement surrounding the parasite (Geraci et al., 1978). In cetaceans the organ systems infected appear to vary by species of host as well as geographic region. Crassicauda sp. has been documented to infect the kidneys, air sinuses, blubber, muscle and fascia, and mammary glands (Baylis, 1932; Arvy 1973-1974; Robineau, 1975; Dailey and Brownell, 1972; Geraci et al., 1976; Dailey and Perrin, 1973; Geraci et al., 1978; Dailey and Walker, 1978; Walker, 1981; Walker et al., 1984; Conlogue et al., 1985; Lambertson, 1985; 1986).

In Phocoenoides dalli, collected in the northern North Pacific, Crassicauda occurs in the blubber, fascia, and mammary glands. Occurrence in the muscle tissue is rare. This is a similar pattern to that described for Crassicauda infected Lagenorhynchus acutus in the North Atlantic (Geraci et al., 1978). Several detailed dissections by the author of Dall's porpoise from the study area indicate that the Crassicauda occurring in the blubber, fascia and mammary glands are the same species of parasite. At present, it is the author's opinion that an individual worm may be of considerable length and potentially occur in all three areas of the body. Continuous tracks of individual worms up to 60 cm in length have been traced through the blubber layer, the fascia and into the mammary glands. Only caudal ends have been recovered from the main lactiferous ducts. The mammary glands may only contain the terminal portions of these parasites.

The life cycle of Crassicauda sp. infecting the mammary glands is unknown. Direct infection of nursing calves through infected milk probably does not occur. Geraci et al. (1978) speculated that host calves may serve only to disseminate larvae to the environment and that maturation of larval stages through intermediate hosts is the probable pattern.

The plerocercoid larvae of the cestode, Phyllobothrium sp. are known to infect the blubber layer in a wide variety of marine mammals throughout the world (Delyamure, 1955; Dailey and Perrin 1973; Testa and Dailey, 1977). The number of species in the genus remains unclear. Eleven morphotypes based on larval morphology have been described and may represent separate species

(Baer, 1932; Guiart, 1935; Delyamure, 1955; and Testa and Dailey, 1977).

Occurrence of Phyllobothrium sp. has been used to distinguish coastal and offshore stocks of Tursiops truncatus in Southern California waters (Walker, 1981). This larval cestode is a particularly valuable biological tag in that it is known to survive up to 13 years in captive cetaceans. The life cycle of Phyllobothrium sp. remains speculative. Testa and Dailey (1977) proposed that the definitive host may be an elasmobranch.

In infected animals Phyllobothrium is likely to be concentrated in the blubber layer immediately adjacent to the genital opening (Dailey and Brownell, 1972). Geraci, et al., 1976 found 80% of the Phyllobothrium in Lagenorhynchus acutus were located in this region.

MATERIALS AND METHODS

Samples and data were collected by U.S. and Japanese observers aboard the mothership fleet of the Japanese high seas salmon gillnet fishery during the 1983-1986 field seasons. The sampling period was during June - July of each year. The area sampled is given in Figure 1. All specimens and data were returned to the National Marine Mammal Laboratory for analysis.

In the 1983 and 1984 field seasons observers were trained to survey a predetermined section of blubber for evidence of Phyllobothrium sp. This survey was conducted as follows: on the left side of each animal returned to the mothership a 17.5 cm x 35.0 cm rectangular section of blubber extending along the midline 17.5 cm anterior to the genital opening and 17.5 cm posterior to

the center of the genital opening and 17.5 cm up the side of the body was sliced into strips at 1/2 cm intervals. These slices were checked for presence of the parasite and, if present, voucher specimens were collected for laboratory confirmation. Since the size of the 17.5 cm x 35.0 cm rectangular section of blubber remained constant, smaller animals were proportionally more intensively surveyed than larger animals. Data recorded in the 1983 and 1984 field seasons were for frequency of occurrence only. Intensity of infection (numbers of parasites present) was not recorded. Frequency of occurrence for Phyllobothrium sp. between 46 degrees to 52 degrees N remained essentially constant for both the 1983 and 1984 field seasons (21.3% and 20.1% respectively). To establish the accuracy of field data, in 1985 identical blubber sections were removed, frozen and returned for laboratory examination. These sections were then thawed and serially sectioned in the same manner as the field samples. The frequency of infection in the 1985 sample was comparable to the two prior years (18.8%). In the 1986 field season blubber samples were collected only from the Bering Sea.

Since occurrence of endoparasites is likely to be age related it is important when studying geographic variation in parasitic load that the age class distribution of the samples be comparable. In this study age through tooth examination of individual hosts was not available. Therefore, total body length is used as an index to age when investigating age related trends in infection rate and geographic variation (see Figs. 2-5). One possible source of bias when using total length as an age index

is if the two populations differ markedly in overall size. Based on cranial morphometrics Walker and Hacker (1985) reported that P. dalli from the Bering Sea are slightly larger in overall size than those from south of the Aleutian Islands. The potential effect of these size related differences should be minimized with the large sample size included in this study.

For purposes of investigating potential geographic variation in the occurrence of Phyllobothrium sp. only animals 160 cm or greater in total length were used. The rational for this size range was as follows:

1) occurrence of this larval cestode in animals below 160 cm in total length is uncommon.
2) occurrence of Phyllobothrium increases with length of host (see Fig. 2).
3) The Bering Sea sample was biased toward smaller animals.

This length criterion reduced the sample to 2,389 animals examined; 1,957 from 46 degrees to 52 degrees N and 432 from 53 degrees to 59 degrees N (see Table 1).

Data on the frequency of infection of Crassicauda sp. were available only for the 1985-86 blubber samples. For purposes of geographic comparison it was decided to compare those animals 140 cm or greater in length. While occurrence of this parasite increases with age it occurs commonly in the blubber in the smaller size classes (figs. 4 & 5). The sample available for study was 831 from 46 degrees to 52 degrees N and 171 from the Bering Sea (53 degrees to 59 degrees N).

RESULTS AND CONCLUSIONS

Analysis of the data reveals geographic variation in frequency of occurrence of both Phyllobothrium and Crassicauda in the northern North Pacific.

The frequency of occurence of the larval cestode, Phyllobothrium sp. in the sample was 22.5%; (n=1957) in the area south of the Aleutians (46 degrees - 52 degrees N). In the Bering Sea (53 degrees - 59 degrees N) the overall frequency was 1.4%; n=432 (Table I). Clinal distribution of Phyllobothrium infected porpoise is evident in the area from 52 degrees to 55 degrees N (Fig. 1). Analysis of the data revealed no relationships between frequency of occurrence, year collected, time, and location of capture. In the area south of the Aleutian Islands there was, however, a strong tendency for Phyllobothrium infected porpoise to occur in small, periodic clusters during each of the three seasons. Data revealed this trend is due to size class separation of Dall's porpoise in the study area. Length frequency data reveals that larger, presumably older animals, are more heavily infected with Phyllobothrium (Fig. 2). This trend supports the findings of other studies on age and sex class segregation in this region (Kasuya and Jones, 1984; Ferrero and Jones, 1986).

The spiruroid nematode, Crassicauda sp. was present in both the northern North Pacific and Bering Sea. Data revealed geographic variation in the frequency of occurrence. The level of infection in the area south of the Aleutians (46 - 52 degrees N) was high (96.1%; Fig. 4). In the Bering Sea (53 - 59 degrees N)

the frequency of occurrence was 31.0%: (Fig. 5). Since data on the parasite were collected only during the 1985 & 1986 field seasons, the sample size from the Bering Sea (171 animals) was too small to permit analysis for potential clinal trends by location of capture.

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TABLE I

SUMMARY OF PHOCOENOIDES DALLI INFECTED
BY THE LARVAL CESTODE, PHYLLOBOTHRIUM SP.
1983 - 1986 FIELD SEASONS

LATITUDE (degrees North)	NUMBER EXAMINED	NUMBER INFECTED	FREQUENCY OF OCCURENCE (%)	MEAN TOTAL LENGTH OF INFECTED SAMPLE (cm)	MEAN TOTAL LENGTH OF TOTAL SAMPLE (cm)
46	22	6	27.3	182.5	178.8
47	25	3	12.0	185.7	177.8
48	28	6	21.4	184.7	179.8
49	311	98	31.5	187.0	183.7
50	765	172	22.5	186.1	181.3
51	693	145	20.9	184.5	180.6
52	113	14	12.4	186.6	177.2
TOTALS	1957	440	22.5	185.3	179.9
53-59	432	6	1.4	187.5	179.6
TOTALS	2389	448		185.6	179.8

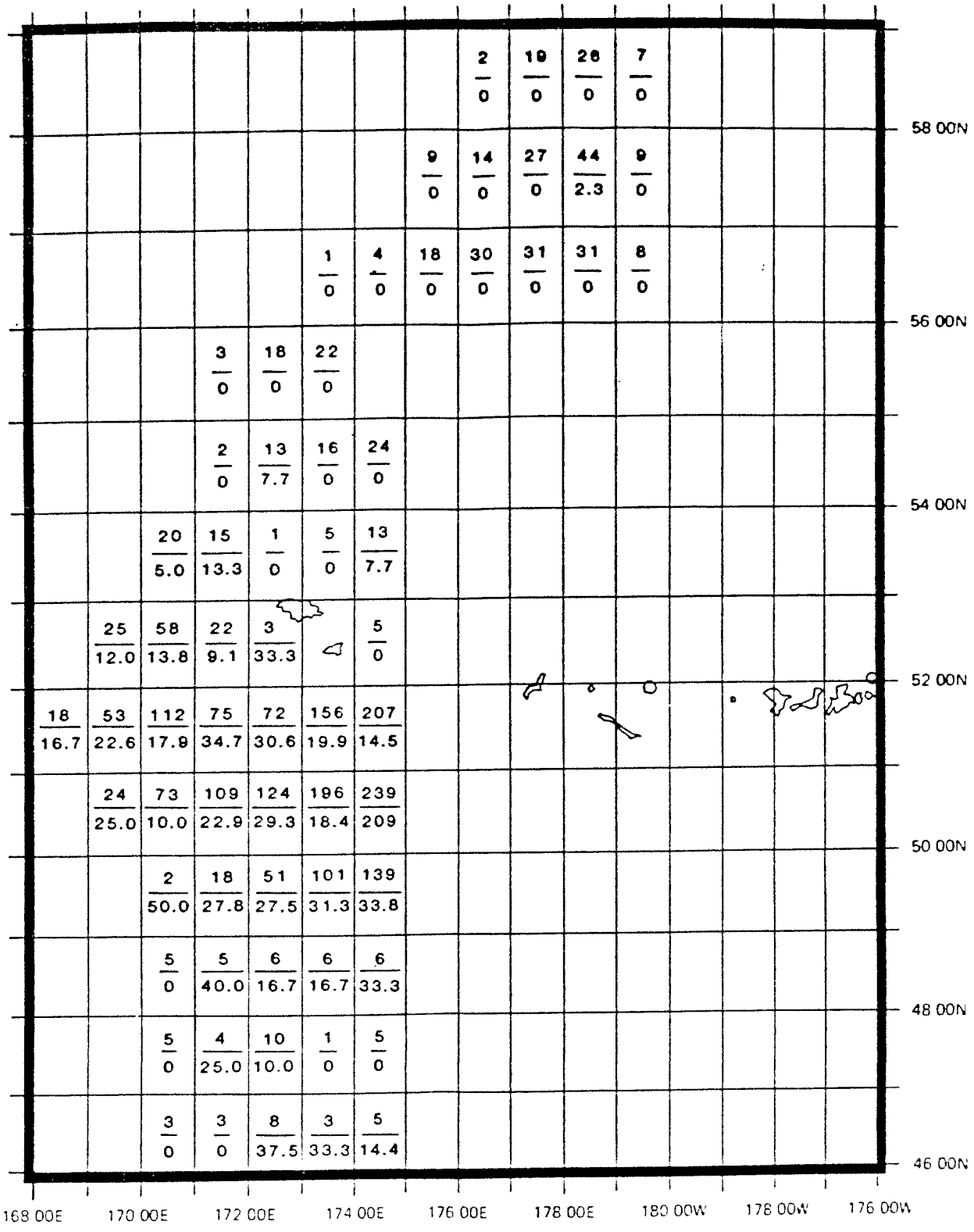

Fig. 1. Frequency of occurrence by one degree squares of Phyllobothrium collected during the 1983 - 86 field seasons. (n. = 2389)

$$\frac{\text{number examined}}{\%\ \text{occurrence}}$$

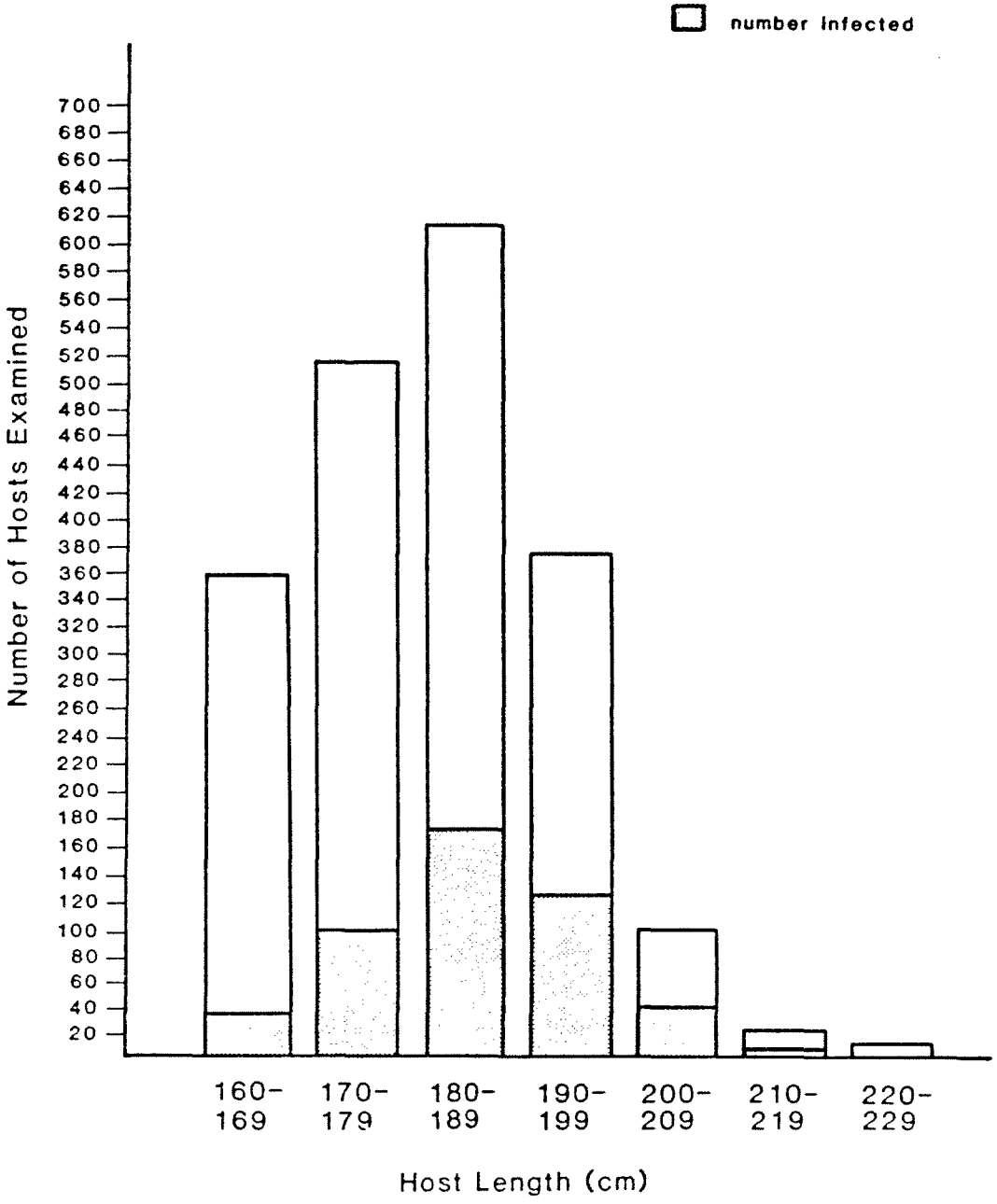

Fig. 2. Length frequency distributions of Phyllobothrium infected Dall's Porpoise sampled 46 -52 degrees N during the 1983 - 86 field seasons. (n. = 1957)

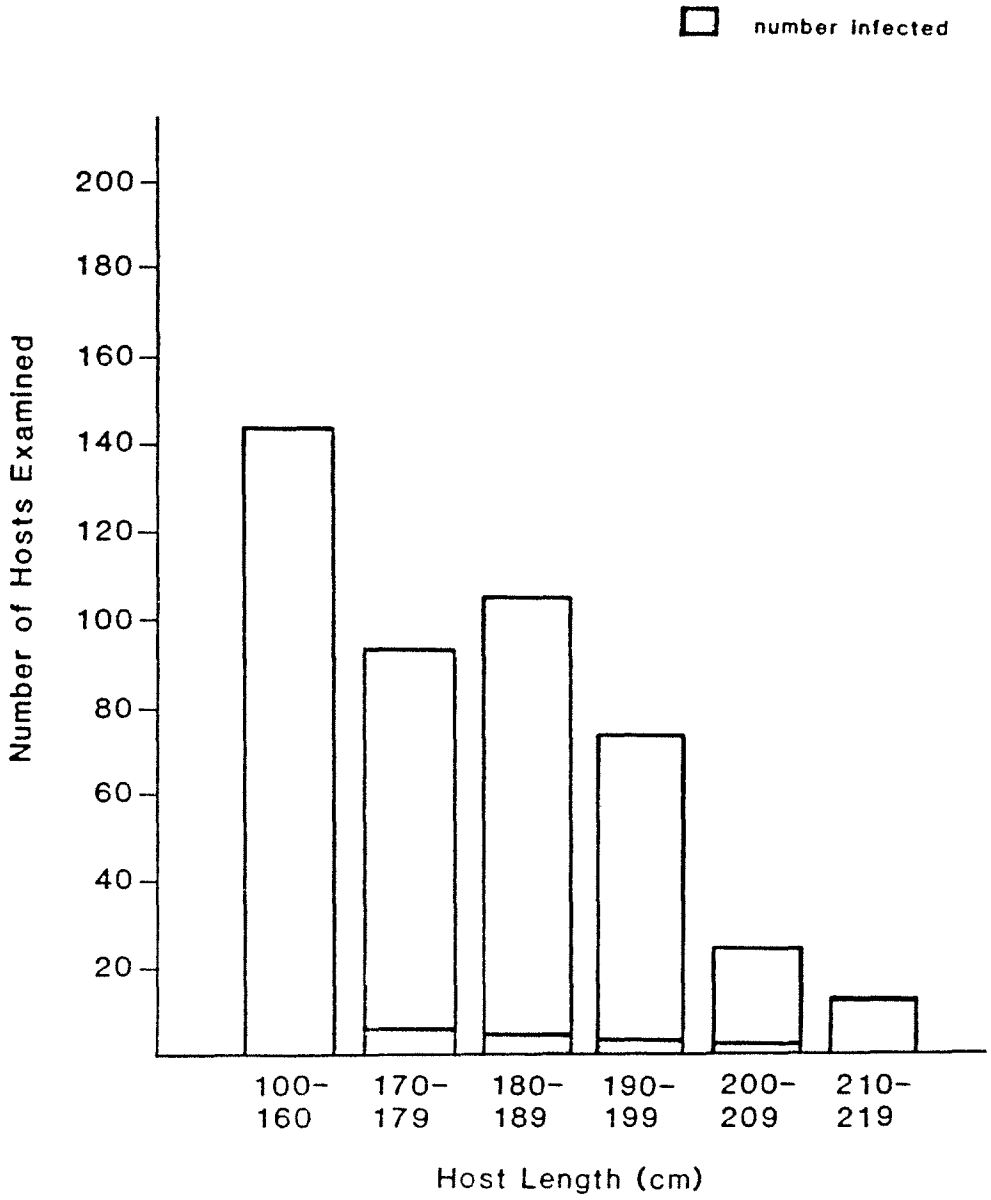

Fig. 3. Length frequency distributions of Phyllobothrium infected Dall's Porpoise sampled 53 - 59 degrees N during the 1983 - 86 field seasons. (n. = 432)

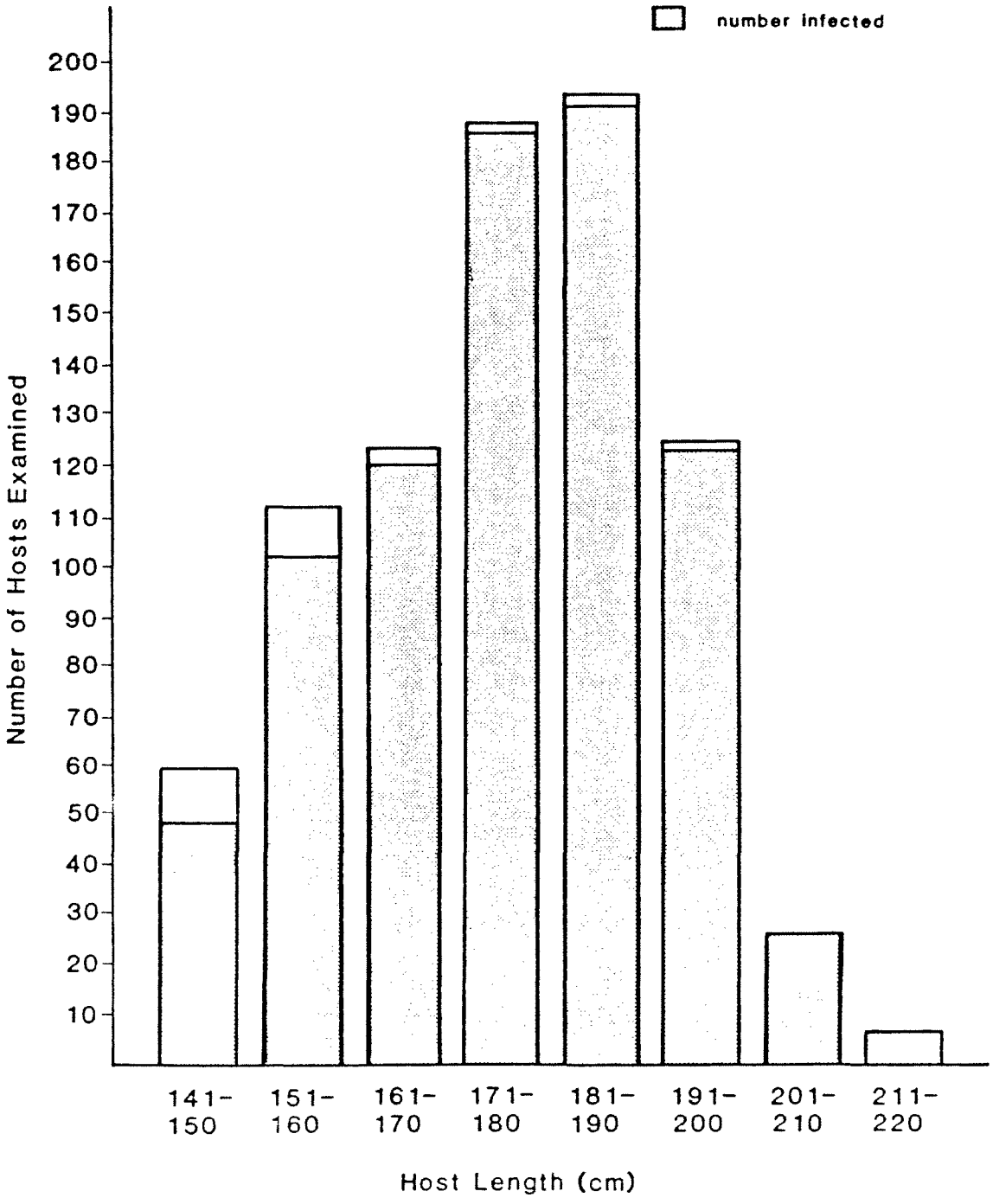

Fig. 4. Length frequency distributions of Crassicauda infected Dall's Porpoise sampled 46 - 52 degrees N during the 1985 - 1986 field seasons. (n. = 841)

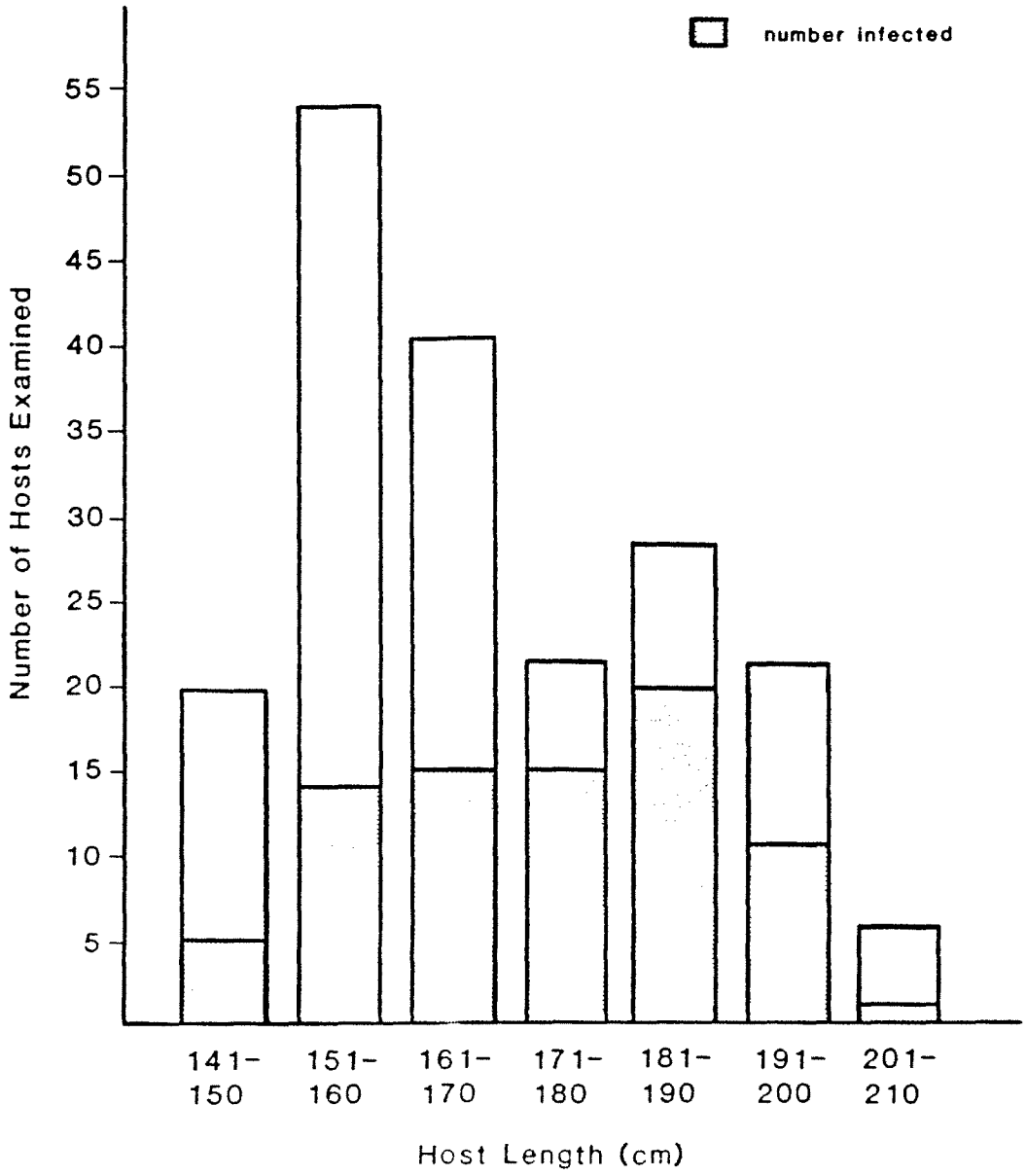

Fig. 5. Length frequency distributions of Crassicauda infected Dall's Porpoise sampled 53 - 59 degrees N during the 1985 - 1986 field seasons. (n. = 191)