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EFFECT OF A RIVER-DOMINATED ESTUARY ON THE PREVALENCE OF *CARCINONEMERTES ERRANS*, AN EGG PREDATOR OF THE DUNGENESS CRAB, *CANCER MAGISTER*

Carcinonemertes errans is a host-specific nemertean that can destroy large numbers of Dungeness crab, *Cancer magister*, eggs (Wickham 1979, 1980). Although the ectosymbiotic nemertean is present on adult and juvenile crabs of both sexes, its only known detrimental effect is to the egg stage. Wickham (1979) estimated that the direct mortality to eggs of Dungeness crabs off central California was 55%. High egg mortalities in the San Francisco, CA, area were suggested as a possible cause of the drastic decline in Dungeness crab populations in that area (Fisher and Wickham 1976; Wickham 1979).

From November 1983 through October 1985, the National Marine Fisheries Service (NMFS) conducted a comprehensive study of the distribution, abundance, and size-class structure of Dungeness crabs in the Columbia River estuary, a river-dominated estuary. Limited sampling was also done in adjacent coastal areas. As an incidental part of the study, we examined crabs for *C. errans*, and observed an effect of the river-dominated estuarine environment on the prevalence of *C. errans* on Dungeness crabs.

Methods

The study was done in the lower Columbia River estuary and adjacent coastal areas (Fig. 1). The estuary is a drowned river mouth that is dominated by river flows. Highest flows typically occur during the spring and lowest flows during late summer and fall. Estimated river flows (monthly averages) during the study period ranged from 3,121 m^3/s (August 1985) to 14,091 m^3/s (May 1985) (U.S. Geological Survey, Portland, OR). Salinities fluctuate widely in the estuary depending on river flow, tidal stage, and distance from the river mouth (Neal 1972). Inversely related to river flows, the salinity intrusion is typically least during spring and greatest during late summer and fall.

Sampling was done monthly at a maximum of 28 estuarine and ocean sites (Fig. 1). At 26 of the sites, an 8 m semiballoon shrimp trawl with stretched mesh size of 38.1 mm was used to collect samples; a 9.5 mm liner was inserted in the cod end of the net to prevent escape of small Dungeness crabs. Sampling in the estuary was normally done during times of higher salinity (early flood to early ebb tide).

Generally a subsample of at least 100 Dungeness crabs (≥20 mm) from each trawl effort was measured to the nearest mm (carapace width, anterior to the 10th anterolateral spines), weighed, sexed, and checked for eggs and *C. errans*. Specific body areas—the undersurface of the abdomen, the thoracic area covered by the abdomen, and the pleopods—were examined for *C. errans*. Dungeness crab catches at individual stations varied considerably, ranging from 0 to >100 crabs per trawl effort. Crabs <20 mm were measured and weighed, but were not routinely sexed or checked for *C. errans*.

Dungeness crabs were separated into four size classes: I (<50 mm), II (50-99 mm), III (100-129 mm), and IV (>129 mm). We used the chi-square test to compare the prevalences of *C. errans* on crabs in the ocean and the estuary and to compare the level of infestation between males and females within the two areas.

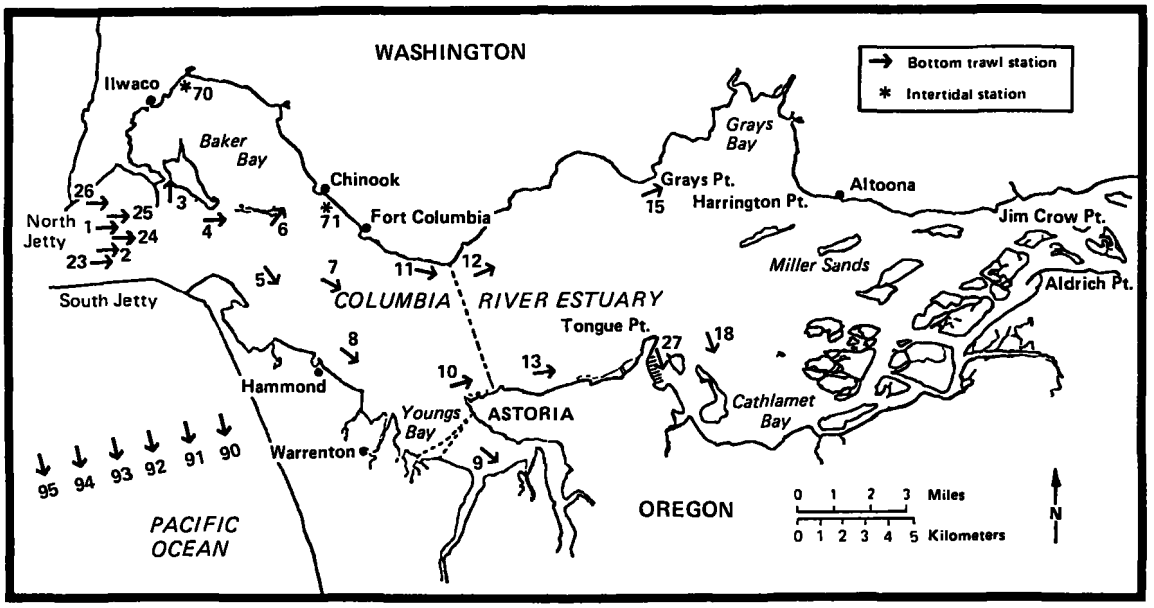

FIGURE 1.—Map of the Columbia River estuary and adjacent coastal areas, showing sampling sites for the 2-yr Dungeness crab study.

Results and Discussion

The prevalence of *C. errans* on Dungeness crabs collected in the estuary was significantly lower than the prevalence on crabs in the ocean (χ^2, df = 1, $P < 0.001$); average prevalences in the estuary and ocean were 6 and 79%, respectively (Tables 1, 2). Within the estuary, mean prevalence was highest at the mouth (stations 1, 2, 23-26) where it averaged 25%. In the estuary, significantly more females (8%) were infested than were males (5%) (χ^2, df = 1, $P < 0.001$), but in the ocean there was no significant difference ($P > 0.05$) in prevalence on males (80%) and females (76%). Only three egg-bearing females were collected during the study; they were collected December 1984 at the mouth of the estuary and in the ocean. One egg-bearing female had an obvious *C. errans* infestation.

In both the estuary and ocean, size class I Dungeness crabs were least frequently infested. No chi-square comparison was done for this size class because of the small numbers of infested crabs. In addition, the total sample size of size class I crabs in the ocean was small (46 crabs). For the individual size classes II-IV, the prevalences of *C. errans* on crabs were significantly lower in the estuary than in the ocean (χ^2, df = 1, $P < 0.001$). In the estuary, the infestation by *C. errans* was highest in size class IV crabs (29%).

The prevalence of *C. errans* found on Dungeness crabs in the ocean and the Columbia River estuary was lower than the prevalence reported by Wickham (1980) in the Bodega Bay, CA, area; he reported that all nonegg-bearing crabs >20 mm carapace width were infested with *C. errans*. In our study, some light infestations may have been missed by not examining the entire exoskeletons of the Dungeness crabs.

The major result of our examinations for *C. errans* was discovering the large difference in infestation levels between the ocean (79%) and the estuary (6%). Low salinities in the estuary, particularly upstream from the mouth, probably were the major cause of the lower infestation. During low river flows (about 4,400 m^3/s), when salinity intrusion is greatest, minimum bottom salinities in most of the lower 22 km of the estuary generally range from 0.5 to 15 ppt, although maximum salinities are ≥30 ppt. During high river flows (about 8,800 m^3/s), minimum bottom salinities in much of the lower 22 km of the estuary may be zero (Jay 1984). Wickham[1] noted that "Pure fresh water will kill worms in 1-2 minutes depending on the worms' size." The lower prevalence in the estuary may have have little effect on the overall prevalence in the ocean. Non-infested Dungeness crabs migrating from the estuary could be infested in the ocean by larval worms (Wickham 1980), or through copulation (Wickham et al. 1984).

[1]D. E. Wickham, Bodega Marine Laboratory, P.O. Box 247, Bodega Bay, CA 94923, pers. commun. November 1985.

TABLE 1.—Prevalence of the egg predator *Carcinonemertes errans* on Dungeness crabs collected in the Columbia River estuary from November 1983 through October 1985.

	Number examined	Number infested	Percent infested
Prevalence by month			
Nov. 1983	362	25	7
Dec. 1983	345	8	2
Jan. 1984	273	3	1
Feb. 1984	160	1	1
Mar. 1984	130	1	1
Apr. 1984	105	9	9
May 1984	84	8	10
June 1984	141	15	11
July 1984	146	6	4
Aug. 1984	248	18	7
Sept. 1984	306	9	3
Oct. 1984	169	11	7
Nov. 1984	218	5	2
Dec. 1984	158	4	3
Jan. 1985	264	1	0
Feb. 1985	59	0	0
Mar. 1985	311	3	1
Apr. 1985	135	6	4
May 1985	238	6	3
June 1985	287	5	2
July 1985	301	8	3
Aug. 1985	262	12	5
Sept. 1985	328	36	11
Oct. 1985	424	122	29
Total	5,454	322	mean, 6
Prevalence by size class			
Size class I	1,273	4	0
Size class II	2,561	102	4
Size class III	1,225	101	8
Size class IV	395	115	29
Prevalence by sex			
Male	3,269	155	5
Female	2,185	167	8

TABLE 2.—Prevalence of the egg predator *Carcinonemertes errans* on Dungeness crabs collected in nearshore areas of the Pacific Ocean from December 1983 through September 1985.

	Number examined	Number infested	Percent infested
Prevalence by month			
Dec. 1983	15	14	93
Jan. 1984	139	113	81
Mar. 1984	13	11	85
Apr. 1984	6	5	83
May 1984	4	3	75
June 1984	7	6	86
July 1984	10	6	60
Aug. 1984	20	17	85
Dec. 1984	5	2	40
Feb. 1985	3	0	0
Apr. 1985	16	15	94
May 1985	3	2	67
July 1985	37	29	78
Aug. 1985	11	7	64
Sept. 1985	130	99	76
Total	419	329	mean, 79
Prevalence by size class			
Size class I	46	1	2
Size class II	115	107	93
Size class III	151	124	82
Size class IV	107	97	91
Prevalence by sex			
Male	276	220	80
Female	143	109	76

Our data indicate that *C. errans* is a marine species that apparently cannot tolerate the lower salinities in the Columbia River estuary. It would be informative to examine Dungeness crabs from other Oregon and Washington estuaries with typically higher salinities to determine if infestation levels are comparable to those in the Columbia River estuary.

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