Alaska whitefish were more or less distended and crammed with eggs, almost all of them least cisco eggs. A few larger eggs in the stomachs were probably those of the Alaska whitefish.

Volume of eggs per stomach ranged between 1.5 and 42.4 ml ($\bar{x}$ = 19.96 ml). Numbers of eggs per stomach ranged between 200 and 7,842 ($\bar{x}$ = 3,574). Other items, present only in insignificant amounts, included Diptera, Tendepedidae, Trichoptera, Hydracarina, unidentified insect parts, a tree bud, and a small slimy sculpin, *Cottus cognatus*.

As indicated previously, extensive life history studies of this species conducted by the Alaska Department of Fish and Game have shown that prespawners do not feed. Presumably, then, the phenomenon reported here is of rare occurrence. However, if the entire Alaska whitefish population of the Chatanika River, estimated at 7,000 to 8,000 fish (see footnotes 1, 2) should engage in this activity, then it might constitute a major source of egg mortality for the least cisco population. Since both species are important components of the sport fishery resources of the Chatanika River, the matter is worth further investigation.

The samples reported upon here were collected as part of a study of the environmental effects of the Trans-Alaska Pipeline crossing of the Chatanika River. This study is conducted jointly by the Division of Life Sciences, University of Alaska, Fairbanks, Alaska, and the Arctic Environmental Research Laboratory, Environmental Protection Agency, Fairbanks, and is supported by the Environmental Protection Agency.

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EGG MORTALITIES IN WILD POPULATIONS OF THE DUNGENESS CRAB IN CENTRAL AND NORTHERN CALIFORNIA[1]

A recent study (Fisher and Wickham 1976) of eggs from wild populations of the Dungeness crab, *Cancer magister*, collected in the 1974-75 season showed that epibiotic fouling and egg mortalities occurred more heavily in the Drakes Bay region of central California than in the other California regions sampled (Pacifica, Point Reyes, Bodega Bay, Russian River, Gualala, Fort Bragg, and Eureka). The paper suggested that nutrients from San Francisco Bay were carried northward by the Davidson Current (the prevalent coastal current during the winter months) causing an increase in epibiotic fouling which restricted gaseous exchange across the egg membrane and increased egg mortalities.

[1]This work is a result of research sponsored by NOAA Office of Sea Grant, U.S. Department of Commerce, under Grant No. 04 5 158-20 NOAA. This work is also supported by California State Legislature Funds for Aquaculture.

In the laboratory it has been shown (Fisher 1976) that increased phosphate and nitrate levels in the seawater did, in fact, increase the number of epibiotic filaments and concurrently the number of egg mortalities. Conversely, chemotherapeutic and antibiotic treatment reduced filamentous growth and egg mortalities. It was also shown that both the number of filaments and the number of egg mortalities decreased exponentially with increasing depth into the egg masses (to a depth of 9 mm).

This study is similar to the original field study (Fisher and Wickham 1976) with modifications based on the information gained in the laboratory. All samples were collected from the same position on the egg masses to discount probable errors due to mortality variations within each egg mass. Only samples with eyespot development and no signs of hatching were used, restricting the variation in developmental states to approximately 2 wk. Mortality estimates were made from both the peripheral eggs of a sample and the total sample to determine the in situ significance of the peripheral mortalities reported for the laboratory conditions (Fisher 1976).

Procedures

The crab eggs were sampled between 26 December 1975 and 27 January 1976 from four regions: Pacifica, Drakes Bay, Russian River, and Eureka. Relative to the mouth of San Francisco Bay, Pacifica is slightly south, Drakes Bay slightly north, Russian River 80 km north, and Eureka 400 km north. Samplers in each area were supplied with curved forceps, vials partially filled with 10% Formalin[2] in seawater, and a data sheet for recording date, depth, and Loran reading for each sample collected. As ovigerous females were captured, small clusters of eggs were removed about 1-2 cm from the posterior tip of the abdomen along the midventral line with the curved forceps and placed in the vials of preservative.

After arrival at Bodega Marine Laboratory, the samples were examined under a dissecting microscope for the presence of eyespots. The samples were discarded if eyespots were lacking or if embryos were beginning to hatch. Laboratory observations have shown the time from eyespot appearance to the time of hatch to be about 2 wk while the entire external incubation period is about 2 mo.

Ten setae were randomly selected from the remaining samples (Pacifica, 27; Drakes Bay, 17; Russian River, 21; Eureka, 23). The first 25 eggs on the distal ends of these setae were examined under the dissecting microscope for mortalities. This provided a peripheral mortality estimate. Percentage peripheral mortalities were calculated from the average mortalities for each region.

The 10 setae from each sample were returned to the sample vials and transferred to a second investigator. Ten to fifteen setae were then randomly selected and an overall mortality estimate was obtained by counting all the live and dead eggs in this subsample (approximately 1,500 eggs). Percentage overall mortalities were calculated for each sample and then averaged for each region.

Results

Drakes Bay samples had the highest mortalities, while those from the Russian River and Eureka had the lowest. The peripheral and overall mortality estimates were consistent for all regions except for Drakes Bay where peripheral mortalities averaged 39.4% and overall mortalities averaged 27.6% (Table 1). A Student's t statistic for the means of two samples showed all regions except Eureka and the Russian River to be significantly different ($P<0.05$) from all other regions using both peripheral and overall mortalities. By the same analysis, the peripheral and overall mortalities within each region were statistically similar ($P>0.1$).

TABLE 1.—Average Dungeness crab egg mortalities for each region sampled. The first 25 eggs on the distal end of 10 setae from each sample were examined.

Region	No. samples	Mortalities	
		Peripheral	Overall
Pacifica	27	14.6 ± 2.0	17.4 ± 1.8
Drakes Bay	17	39.4 ± 5.4	27.6 ± 5.0
Russian River	21	8.1 ± 1.0	9.7 ± 1.4
Eureka	23	9.1 ± 1.6	11.5 ± 1.6

Discussion

These results agree with the original study completed during the 1974-75 season. High numbers of egg mortalities were found in the Drakes Bay region and low numbers in samples from the Eureka and the Russian River regions.

[2]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

The lower mortalities from the adjacent Pacifica and Russian River regions confirm the suggestion of the original study that the heavy mortalities were substantially confined to the Drakes Bay region. This is consistent with the suggestion that the northerly Davidson Current may be sweeping harmful effluent from San Francisco Bay into Drakes Bay. The intermediate mortality levels of the Pacifica region could simply be a result of proximity while the Russian River region might remain relatively unaffected due to blockage and dispersion caused by the Point Reyes land mass and to dilution of the harmful effluent.

The similarity between the peripheral and overall mortalities found for the Pacifica, Russian River, and Eureka regions show a constant mortality distribution throughout the egg masses in these areas. The Drakes Bay region, however, showed considerably higher peripheral mortalities (39.4%) compared with the overall mortalities (27.6%). It is surmised that the peripheral mortalities are the primary difference between the high number of mortalities found in Drakes Bay and the lower numbers in other regions. This parallels the distribution of mortalities caused by epibiotic fouling in the laboratory (Fisher 1976) which were found to decrease with increased depth into the egg mass and further supports the proposition that epibiotic fouling contributes to egg mortalities in the Dungeness crab population of Drakes Bay.

There are several similarities between this egg disease and that of the blue crab, *Callinectes sapidus*, caused by the fungus, *Lagenidium callinectes* (Couch 1942; Sandoz et al. 1944). Both conditions are geographically selective, cause peripheral mortalities, cause greater damage on older egg masses, and coincide with increased nemertean worm populations (Rogers-Talbert 1948; Fisher and Wickham 1976). It is interesting to note that some epibiotic microorganisms were also observed on the blue crab eggs (Rogers-Talbert 1948). These similarities may indicate a common factor such as environmental stress or physiological impairment of the eggs that supercedes the importance of the respective etiological agents.

It is difficult to ascertain the effect of the Dungeness crab egg mortalities in Drakes Bay on the recruitment of the commercially important adult stages. Specific production data for Drakes Bay and migration patterns for the species are unknown. Although no attempts have been made to bear out the suggestion, Rogers-Talbert (1948) felt that 25% mortality found on the blue crab eggs could not be regarded as a factor in (adult) population fluctuations. Recently, larval stages of the Dungeness crab have also been found susceptible to epibiotic microbial infestation in the laboratory (Fisher and Nelson[3]) although no field data are available. It can at least be speculated that the combined losses of egg and larval stages have decreased the adult population of Dungeness crabs in Drakes Bay. This decrease is reflected by the collapse of the fishery in central California since 1960 while northern California production, although fluctuating, has been maintained (Orcutt et al. 1975).

Acknowledgments

We thank Harold Ames, Tom Burke, Earl Carpenter, Bill Genochio, Tony Anello, Willie Ancona, Tom Estes, and Charles Fagg for their sampling efforts and Richard Nelson for his technical assistance.

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