Cancer magister

Dungeness or market crab

Phylum: Arthropoda, Crustacea

Class: Multicrustacea, Malacostraca, Eumalacostraca

Order: Eucarida, Decapoda, Pleocyemata, Brachyura, Eubrachyura, Heterotremata

Family: Cancroidea, Cancridae

Taxonomy: Recent morphological studies have elevated the subgenus *Metacarcinus* to genus level (Schweitzer and Feldmann 2000). However, molecular work does not always support the monophyly of this or other cancrid genera (Harrison and Crespi 1999). Although many researchers have switched to the name *Metacarcinus magister* (e.g. Wicksten 2011; Rasmuson and Shanks 2014; Dunn and Young 2014), we follow current local intertidal guides and reviews of the species that retain the name *Cancer magister* (e.g. Kuris et al. 2007; Rasmuson 2013).

Description

Size: Carapace 120.7 mm in length, 177.8 mm in width. Up to 1.36 kg in weight, though average weight of four-year old (i.e. fully mature) males is 0.91 kg (Rasmuson 2013).

Color: Light reddish brown, darkest anteriorly, often light orange below (Rathbun 1930), sometimes with gray-purple mottling dorsally. Inner sides of anterior dactyls and propodi crimson, but tips not darkly pigmented (Rathbun 1930; Kuris et al. 2007).

General Morphology: The body of decapod crustaceans can be divided into the **cephalothorax** (fused head and thorax) and **abdomen**. They have a large plate-like carapace dorsally, beneath which are five pairs of thoracic appendages (see **chelipeds** and **pereopods**) and three pairs of maxillipeds (see **mouthparts**). The abdomen and associated appendages are reduced and folded ventrally (Decapoda, Kuris et al. 2007).

Cephalothorax:

Eyes: Eyestalks short, orbits small.

Antenna: Antennules folded lengthwise and antennal flagella short and, more or less, hairy (Rathbun 1930).

Mouthparts: The mouth of decapod crustaceans is comprised of six pairs of appendages including one pair of mandibles (on either side of the mouth), two pairs of maxillae and three pairs of maxillipeds. The maxillae and maxillipeds attach posterior to the mouth and extend to cover the mandibles (Ruppert et al. 2004).

Carapace: Broadly oval, uneven but not highly sculptured and with granular texture. Carapace width greatest at tenth tooth (Fig. 1). Postero-lateral margin is unbroken, entire and without teeth. The antero-lateral margin meets the postero-lateral margin with distinct angle (Fig. 1).

Frontal Area: No rostrum. Narrow and with five unequal teeth, not markedly produced beyond outer orbital angles. Middle tooth largest and more advanced than outer pair. The outer pair form inner orbital angles (Fig. 2).

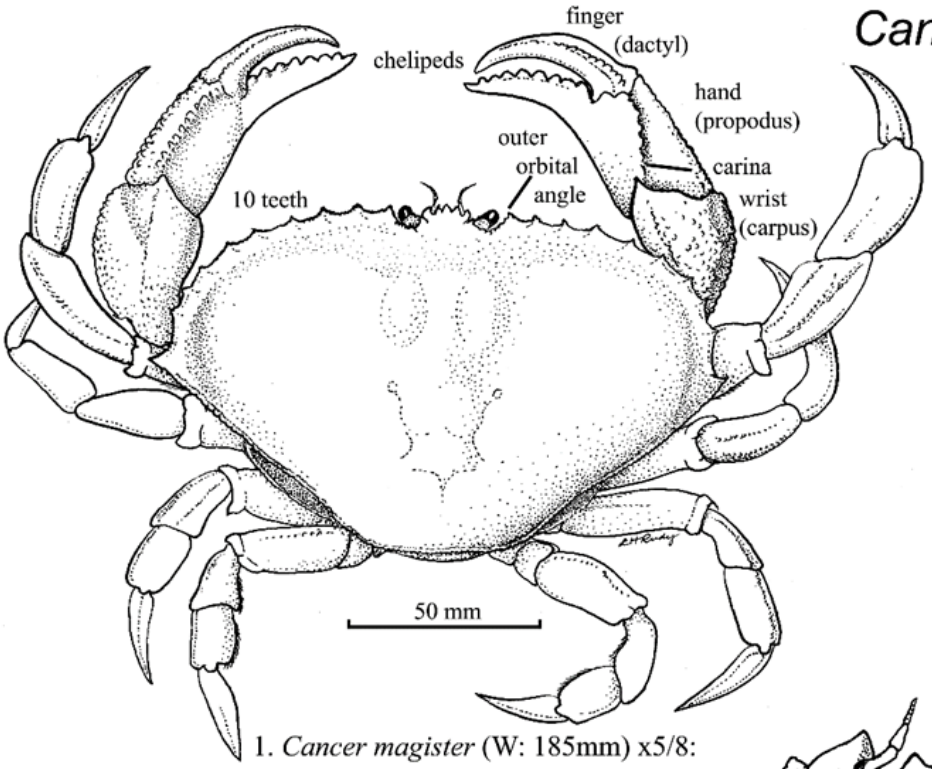
Teeth: Ten antero-lateral teeth, counting the orbital tooth. All teeth are pointed and with anterior serrations. The tenth tooth is large and projecting.

Pereopods: Rough above, broad and flat (especially the propodus and dactylus of last pair).

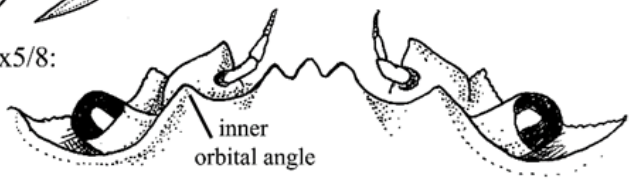
Chelipeds: Dactyls not pigmented and dactyl spines on upper surface. The fixed finger is much deflexed. The hand (propodus) has six carineae on upper outer surface and the wrist (carpus) has a strong inner spine (Fig. 1).

Abdomen (Pleon): Abdomen narrow in male,

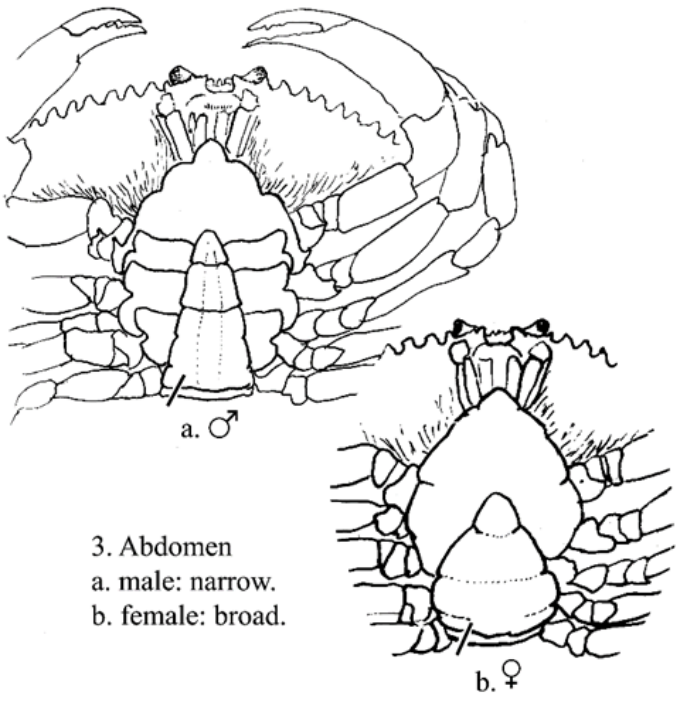
Cancer magister



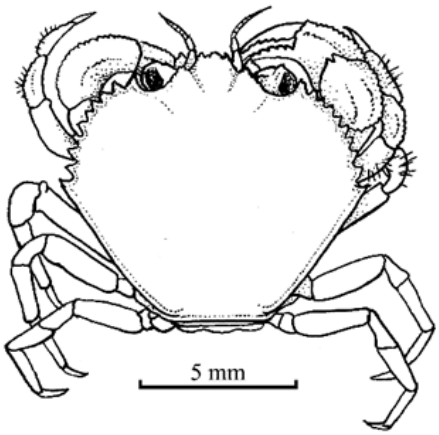
1. *Cancer magister* (W: 185mm) x5/8:
ten antero-lateral teeth;
postero-lateral margin entire;
front: five unequal teeth;
carapace: broadly oval, widest at
tenth tooth; fingers light.



2. Front:
not markedly pronounced; middle
tooth largest, most advanced;
outer pair form inner orbital angles.



3. Abdomen
a. male: narrow.
b. female: broad.



4. Juvenile (W: 10mm) x5:
carapace rectangular; ten
teeth; fingers light.

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broad in female (Fig. 3).

Telson & Uropods: One feature that may be taxonomically relevant to the placement of this species within *Metacarcinus* or *Cancer* (see **taxonomy**) is the telson morphology. The genus *Metacarcinus* is characterized by males with a rounded tip to the telson, while the males of *Cancer* species have a more sharply pointed telson tip (Schram and Ng 2012).

Sexual Dimorphism: Male and female brachyuran crabs are easily differentiable. The most conspicuous feature, the abdomen, is narrow and triangular in males while it is wide and flap-like in females (Fig. 3). Additionally, males have one large chelae and two pleopod pairs specialized for copulation, however, the third and fourth pleopods are absent. Females, on the other hand, have all four pleopod pairs, each with long setae for egg attachment (Brachyura, Kuris et al. 2007).

Possible Misidentifications

According to some authors, the genus *Cancer* comprises 23 species (Harrison and Crespi 1999). This genus is differentiated from other brachyuran genera by the broadly oval carapace, presence of five frontal teeth and antennules that fold back over carapace. Characters unique to *Cancer magister* include 10 antero-lateral teeth, carapace widest at tenth tooth and the lack of black-tipped cheliped dactyls.

There are eight *Cancer* species known locally (Kuris et al. 2007). *Cancer productus*, the most morphologically similar to *C. magister*, also has 10 antero-lateral teeth and five subequal (but nearly equal) frontal teeth (Kuris et al. 2007). However, its cheliped dactyls are black tipped, its carapace is widest at the ninth tooth and its body color can be uniformly brick red (characters not observed in *C. magister*) (Wicksten 2011). *Cancer antennarius*, like *C. productus*, is dark red with spots ventrally and with black tipped chelae. However, the carapace width in *C. antennarius* is widest at the eighth tooth and there are a total of 11 antero-lateral teeth (Wicksten 2011). *Cancer oregonensis* is a small, oval crab with 12–13 total teeth. The remaining four species have nine antero-lateral teeth (sometimes ten in older specimens, Wicksten 2011). *Cancer branneri* is a small species (35 mm) that is rare intertidally and recognizable by cheliped dactyls that are long, straight, black and spiny. *Cancer gracilis* is also small (27 mm) has white-tipped cheliped dactyls and *C. jordani* (25 mm) has a hairy carapace and sharp curving teeth. *Cancer anthonyi*, the yellow rock crab, is larger than the previous three at 52 mm and has black-tipped cheliped dactyls (Kuris et al. 2007; Wicksten 2011). Populations of *C. productus*, *C. anthonyi* (southern California) and *C. magister* support commercial fisheries (Kuris et al. 2007). Due to the extensive commercial fishery for *C. magister* (Alaska to California) there are many extensive reviews on this species (e.g. Wild and Tasto 1983; Pauley et al. 1989; Rasmuson 2013).

Ecological Information

Range: Type locality is San Francisco Bay (Schmitt 1921). Known range includes Alaska to Monterey Bay, California (Ricketts and Calvin 1971).

Local Distribution: Most local northwest estuaries and offshore waters. Also near shore and within bays in summer months (Ricketts and Calvin 1971).

Habitat: Individuals are found in many substrates, from mud to sand, gravel and rock (Schmitt 1921). *Cancer magister* appears to prefer sand (Weymouth 1914) and mud with eelgrass in bays (Kozloff 1974). Juveniles and adults tend to bury themselves into soft sand (Jaffe et al. 1987; McGaw 2005). In particular, females must be buried 5–10 cm deep to attach embryos to their pleopods (Fisher

and Wickham 1976).

Salinity: In Coos Bay, individuals were collected at salinities from 11–35 (Dunn and Young 2013). Juvenile crabs are more tolerant to low salinity (Hunter and Rudy 1975; Robinson and Potts 1979). Dunn and Young (2013) found that the salinity tolerance of adult crabs may provide them refuge from the nemertean egg predator that is more prevalent in areas of high salinity.

Temperature:

Tidal Level:

Associates: Both male and female *C. magister* are usually infested with the nemertean egg predator *Carcinonemertes errans* (Wickham 1979a, b; Dunn and Young 2013). These worms occur all over the body of adults, particularly near the joints or abdominal flap and are transferred from males to females during copulation where they, eventually move toward the egg mass. The life-cycle of this nemertean is dependent on and corresponds to that of *C. magister* (Kuris 1993).

Abundance: Commercial catch in Oregon is cyclic in nature and has ranged from a high of 15,112,000 kg (2006) to a low of 224,000 kg (1928) (Fig. 3.3, Rasmuson 2013). Population fluctuations appear to be driven by two factors: 1) Initially the population is recruitment limited and the number of returning megalopae directly correlates to adult population size (Shanks 2013); 2) The number of returning megalopae are correlated with the local timing of the spring transition, the phase of the Pacific Decadal Oscillation and the amount of upwelling during the season's megalopae recruit. When the number of returning megalopae is high, it appears that the adult population is set by density dependent effects.

Life-History Information

Reproduction: When the female is about to molt (March–June, Oregon), male *C. magister* clasp females and copulation takes place over several days (Snow and Nielsen 1966; Rasmuson 2013). Fertilization is internal and occurs after molting and egg deposition occurs months later. Eggs are approximately 390–420 µm in diameter and females carry broods up to 2.5 million from October to December. Eyespots and chromatophores are easily visible in advanced embryos (80 days at 10˚C, Jaffe et al. 1987; Kuris et al. 2007). The larval duration ranges from 89–143 days (average 130), hatching occurs between January and March with settlement between April and August in Oregon and Washington (Table 3.1, Rasmuson 2013). See Rasmuson 2013 (Fig. 3.2) for *C. magister* life cycle.

Larva: Larval development proceeds via a series of zoea (five total) and megalopae stages, each marked by a molt. *Cancer magister* zoea are planktotrophic and have large compound eyes and four spines: one each dorsal and rostral and two lateral (see Fig. 31, Puls 2001; Rasmuson 2013; Martin 2014). Larval size (measured from tip of rostrum to tip of telson) proceeds from 2.5 mm (Zoea I) to 9 mm (Zoea V) (Puls 2001). The zoea of cancrid species are difficult to distinguish but the megalopae of *C. magister* are distinctly larger than other cancrid species (up to 6.6 mm vs 3 mm) (Puls 2001). Larval duration is estimated to be 80–160 days at 10˚C, where 25–30 days are spent as megalopae (Jaffe et al. 1987; Puls 2001). Larval forms occur in nearshore waters and progressively move offshore. They return to nearshore shelf waters, bays and estuaries for metamorphosis. It is a common misconception that the larvae must settle in estuaries and, in reality, most settle on the continental shelf (Rasmuson 2013).

Juvenile: As in adults, the antero-lateral and postero-lateral margins meet with a distinct angle. The carapace is widest at the tenth tooth and postero-lateral margin is entire.

The carpus of each cheliped is with single spine and dactyls are not pigmented (Rathbun 1930). The carapace of juveniles is not as broad as in adults (compare Figs. 1 and 4).

Longevity: Lifespan ranges from 7–10 years (Ricketts and Calvin 1971; Gutermuth 1989) however fishery-based mortality truncates the lifespan of male *C. magister* to approximately four years.

Growth Rate: The “first crab" stage is reached at 80 days, at 11 °C (Anderson 1978). Sexual maturity is reached at $1^{3}/_{4}$ years (Morris et al. 1980) and individuals fully mature at 4–5 years (Ricketts and Calvin 1971). Growth rates by age are as follows: males and females at age 1 yr are 30 mm; males and females at age 2 yr are 95 mm; at age 3 yr males are 150 mm and females are 120 mm; and males at age 4 yr are 175 mm. A characteristic of ecdysozoans is growth that is punctuated by molting (ecdysis). Pre-molting periods are defined by the separation of the epidermis from the old cuticle and the dramatic increase in epidermal cell growth. Post-molt periods are recognizable by individuals that have soft shells as the cuticle gradually hardens and deposits a thin membranous layer. Furthermore, decapods have the ability to regenerate limbs, which have been autotomized as necessary, at subsequent molts (Kuris et al. 2007).

Food: An opportunistic feeder. Bivalves appear to be the most important food though fish bones and crustaceans have been found in the guts of *C. magister* (Butler 1954). Young-of-the-year crabs are highly cannibalistic (Fernandez 1993).

Predators: Adults are commercially and recreationally harvested for food. In Washington and Oregon, *C. magister* is the most economically important fishery and the second most in California (Rasmuson 2013). Larval forms are eaten by plankton feeders (herring, salmon, other fishes). Juveniles and adults are commonly consumed by benthic fishes (Reilly 1983; Armstrong et al. 2003). *Cancer magister* equate to ~15% of the diet of sea otters in southeast Alaska. The egg broods of *C. magister* are predated by the nemertean worm, *Carcinonemertes errans* (Wickham 1979a, b) that can significantly reduce egg clutch size (Wickham 1986).

Behavior: Tagging studies report movement distances ranging from 0.2 to >100 km though the average is 1.1–3.2 km (Cleaver 1949; Hildenbrand et al. 2012). Juveniles and adults are adept at digging both to bury within sediment and are also able to capture infaunal organisms (Butler 1954; Stevens et al. 1982).

Bibliography

1. ANDERSON, W. 1978. A description of laboratory-reared larvae of the yellow crab, *Cancer anthonyi* Rathburn (Decapoda: Brachyura) and comparison with larvae of *Cancer magister* Dana and *Cancer productus* Randall. Crustaceana. 34:55-68.
2. ARMSTRONG, D. A., C. ROOPER, and D. GUNDERSON. 2003. Estuarine production of juvenile Dungeness crab (*Cancer magister*) and contribution to the Oregon-Washington coastal fishery. Estuaries. 26:1174-1188.
3. BUTLER, T. 1954. Food of the commercial crab in the Queen Charlotte Islands regions. Canadian Fisheries Research Board Pacific Progress Report. 99:3-5.
4. CLEAVER, F. C. 1949. Preliminary results of the coastal crab (*Cancer magister*) investigation. State of Washington, Dept. of Fisheries, [Olympia].
5. DUNN, P. H., and C. M. YOUNG. 2013. Finding refuge: The estuarine distribution of the nemertean egg predator *Carcinonemertes errans* on the Dungeness crab, *Cancer magister*. Estuarine Coastal and Shelf Science. 135:201-208.

6. —. 2014. Larval settlement of the nemertean egg predator *Carcinonemertes errans* on the Dungeness crab, *Metacarcinus magister*. Invertebrate Biology. 133:201-212.
7. FERNANDEZ, M., D. ARMSTRONG, and O. IRIBARNE. 1993. First cohort of young-of-the-year Dungeness crab, *Cancer magister*, reduces abundance of subsequent cohorts in intertidal shell habitat. Canadian Journal of Fisheries and Aquatic Sciences. 50:2100-2105.
8. FISHER, W. S., and D. E. WICKHAM. 1976. Mortalities and epibiotic fouling of eggs from wild populations of Dungeness crab, *Cancer magister*. Fishery Bulletin. 74:201-207.
9. GUTERMUTH, F. B., and D. A. ARMSTRONG. 1989. Temperature dependent metabolic response of juvenile Dungeness crab, *Cancer magister* Dana: ecological implications for estuarine and coastal populations. Journal of Experimental Marine Biology and Ecology. 126:135-144.
10. HARRISON, M. K., and B. J. CRESPI. 1999. Phylogenetics of Cancer crabs (Crustacea : Decapoda : Brachyura). Molecular Phylogenetics and Evolution. 12:186-199.
11. HILDENBRAND, K., R. EDER, and A. GLADICS. 2012. Adult male Dungeness crab (*Cancer magister*) movements near Reedsport, Oregon from a fisheries collaborative mark-recapture study. Journal of Shellfish Research. 31:296-297.
12. HUNTER, K. C., and P. P. RUDY. 1975. Osmotic and ionic regulation in Dungeness crab, *Cancer magister*. Comparative Biochemistry and Physiology Part A. 51:439-447.
13. JAFFE, L. A., C. F. NYBLADE, R. B. FORWARD, and S. SULKIN. 1987. Phylum or subphylum Crustacea, class Malacostraca, order Decapoda, Brachyura, p. 451-475. *In:* Reproduction and development of marine invertebrates of the northern Pacific coast. M. F. Strathmann (ed.). University of Washington Press, Seattle, WA.
14. KOZLOFF, E. N. 1993. Seashore life of the northern Pacific coast: an illustrated guide to northern California, Oregon, Washington, and British Columbia. University of Washington Press, Seattle, WA.
15. KURIS, A. M. 1993. Life cycles of nemerteans that are symbiotic egg predators of decapod crustacea: adaptations to host life histories. Hydrobiologia. 266:1-14.
16. KURIS, A. M., P. S. SADEGHIAN, J. T. CARLTON, and E. CAMPOS. 2007. Decapoda, p. 632-656. *In:* The Light and Smith manual: intertidal invertebrates from central California to Oregon. J. T. Carlton (ed.). University of California Press, Berkeley, CA.
17. MARTIN, J. W. 2014. Brachyura, p. 295-310. *In:* Atlas of crustacean larvae. J. W. Martin, J. Olesen, and J. T. Høeg (eds.). Johns Hopkins University Press, Baltimore, MD.
18. MCGAW, I. J. 2005. Burying behaviour of two sympatric crab species: *Cancer magister* and *Cancer productus*. Scientia Marina. 69:375-381.
19. PAULEY, G. B., D. A. ARMSTRONG, R. VAN CITTER, and G. L. THOMAS. 1989. Species Profiles, Life histories and environmental requirements of coastal fishes and invertebrates. Pacific southwest: Dungeness crab.
20. PULS, A. L. 2001. Arthropoda: Decapoda, p. 179-250. *In:* Identification guide to larval marine invertebrates of the Pacific Northwest. A. Shanks (ed.). Oregon State University Press, Corvallis, OR.
21. RASMUSON, L. K. 2013. The Biology, ecology and fishery of the Dungeness crab, *Cancer magister*. Advances in Marine Biology. 65:95-148.

22. RASMUSON, L. K., and A. L. SHANKS. 2014. In situ observations of Dungeness crab megalopae used to estimate transport distances by internal waves. Marine Ecology Progress Series. 511:143-152.
23. RATHBUN, M. J. 1930. The Cancroid crabs of America of the families Euryalidae, Portunidae, Atelecyclidae, Cancridae and Xanthidae. U.S. Government Printing Office, Washington, D.C.
24. REILLY, P. N. 1983. Predation on Dungeness crabs, *Cancer magister*, in central California, USA. Fish Bulletin. 172:155-164.
25. RICKETTS, E. F., and J. CALVIN. 1971. Between Pacific tides. Stanford University Press, Stanford, California.
26. ROBINSON, G. D., and W. T. W. POTTS. 1979. Ion fluxes and diffusion potentials in the Dungeness crab, *Cancer magister*. Journal of Comparative Physiology. 131:285-292.
27. RUPPERT, E. E., R. S. FOX, and R. D. BARNES. 2004. Invertebrate zoology: A functional evolutionary approach. Thomson Brooks/Cole, Belmont, CA.
28. SCHMITT, W. L. 1921. The marine decapod crustacea of California. University of California Publications in Zoology. 23:1-470.
29. SCHRAM, F. R., and P. K. L. NG. 2012. What is Cancer? Journal of Crustacean Biology. 32:665-672.
30. SCHWEITZER, C. E., and R. M. FELDMANN. 2000. Re-evaluation of the Cancridae Latreille, 1802 (Decapoda: Brachyura) including three new genera and three new species. Contributions to Zoology. 69:223-250.
31. SHANKS, A. L. 2013. Atmospheric forcing drives recruitment variation in the Dungeness crab (*Cancer magister*), revisited. Fisheries Oceanography. 22:263-272.
32. SNOW, C. D., and J. R. NIELSEN. 1966. Pre-mating and mating behavior of the Dungeness crab. Journal of the Fisheries Research Board of Canada. 23:1319-1323.
33. STEVENS, B. G., D. A. ARMSTRONG, and R. CUSIMANO. 1982. Feeding habits of the Dungeness crab, *Cancer magister*, as determined by the index of relative importance. Marine Biology. 72:135-145.
34. WALDRON, K. D. 1958. The fishery and biology of the Dungeness crab (*Cancer magister* Dana) in Oregon waters. Contribution, Oregon Fish Commission. 24:1-43.
35. WEYMOUTH, F. W. 1914. Contributions to the life-history of the Pacific coast edible crab. Report of the British Columbia Commission of Fisheries. 1914:123-129.
36. WICKHAM, D. E. 1979a. Predation by the nemertean *Carcinonemertes errans* on eggs of the Dungeness crab *Cancer magister*. Marine Biology. 55:45-53.
37. —. 1979b. The Crab-egg predator, *Carcinonemertes errans*: a cycling and collapse of Dungeness Crab Population. Ph.D., University of California, Berkeley, CA.
38. —. 1986. Epizootic infestations by nemertean brood parasites on commercially important crustaceans. Canadian Journal of Fisheries and Aquatic Sciences. 43:2295-2302.
39. WICKSTEN, M. K. 2011. Decapod crustacea of the Californian and Oregonian Zoogeographic Provinces. http://escholarship.org/uc/item/7sk9t2dz. Scripps Institution of Oceanography, UC San Diego, San Diego, CA.
40. WILD, P. W., and R. N. TASTO. 1983. Life history environment and mariculture studies of the Dungeness crab, *Cancer magister*, with emphasis on the central California USA fishery resource. Fish Bulletin. 172:1-352.

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T.C. Hiebert and L. Rasmuson