Petrolisthes cinctipes

The flat porcelain crab

Phylum: Arthropoda, Crustacea
Class: Malacostraca
Order: Decapoda
Section: Anomura, Hippoidea
Family: Porcellanidae

Taxonomy: *Petrolisthes cinctipes* is and has been a widely used name for this species. There are, however, several junior synonyms including *Porcellana cinctipes*, *Porcellana rupicola*, and *Petrolisthes rupicolus* (for all synonyms see Haig 1960; Wicksten 2011).

Description

Size: Individuals up to 24 mm in length (carapace width) (Puls 2001; Wicksten 2011). The illustrated specimen (from Coos Bay) is 14 mm in length and weighs 1.7 g.

Color: Dark blue-brown and somewhat iridescent (see Plate 20, Kozloff 1993). Antennae dark red, maxillipeds bright red-orange and legs blue banded with white (Schmitt 1921). White comma-like marks are sometimes present ventrally and chelipeds bear a red spot at dactyl base, while walking legs have a yellow median band on propodus. Dactyls yellow with narrow brown band. Individuals near molting are blue in color (Wicksten 2011).

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 body of the Porcellanidae is crab-like and convex longitudinally with small fifth legs resting on carapace (Fig. 1) and the abdomen and associated appendages are reduced and folded ventrally. The body and chelae of *Petrolisthes* are flattened (Kuris et al. 2007).

Cephalothorax:

Eyes: The eyestalks of *P. cinctipes* contain neurosecretory cell bodies (z-organs) that regulate regeneration, molting and oocyte maturation (Kurup 1964a).

Antennae: Very long, and often folded posteriorly over carapace sides (Fig. 1). First (basal) joint of antennal peduncle is short and not reaching upper margin of carapace.

Mouthparts: The mouth of decapod crustaceans comprises 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). Second maxillipeds in *P. cinctipes* are highly developed for filter feeding (see **Food**) with long fine hairs and specialized shape for channeling water currents (Fig. 4). The color of the palps of maxilliped three are of taxonomic importance: blue in *P. eriomerus* and orange in *P. cinctipes* (Kozloff 1993; Kuris et al. 2007).

Carapace: Round with carapace front triangulate *(Petrolisthes,* Haig 1960). Carapace surface is finely granulate and not rough. No epibranchial (anterolateral) spines and epimera and lateral portions of carapace are entire (Figs. 1, 2). Carapace about as long as wide (Wicksten 2011).

Frontal Area: Triangular and strongly deflexed with conspicuous median groove (Fig. 1).

Teeth:

Pereopods: Waking legs 2–4 with a few coarse spines on dactyl, propodus and carpus, but not on merus (Fig. 1). Merus of third leg is inflated and carpus is without setae while propodus and dactyl bear setae. Fifth legs small, elevated and rest on carapace (Figs. 1, 3).

Chelipeds: Equal (or almost), broad and flattened, not thick and rough (*Petrolisthes,* Schmitt 1921; Kuris et al. 2007), covered with fine granules (as in carapace) but without setae. Carpus almost invariably 1 1/2 times longer than wide and anterior and posterior margins converge distally (Schmitt 1921; Kuris et al. 2007) (Fig. 1). Posterior margin with ridge of tubercles flanked by teeth distally. Prominent lobe at inner angle (*P.*

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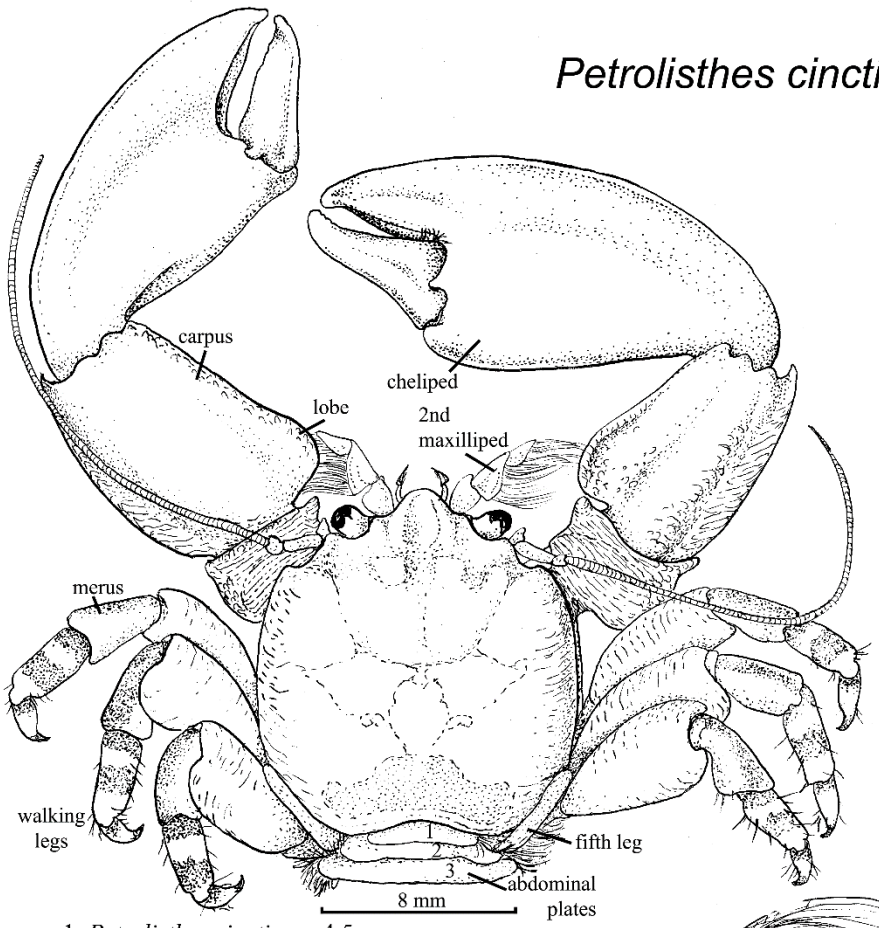
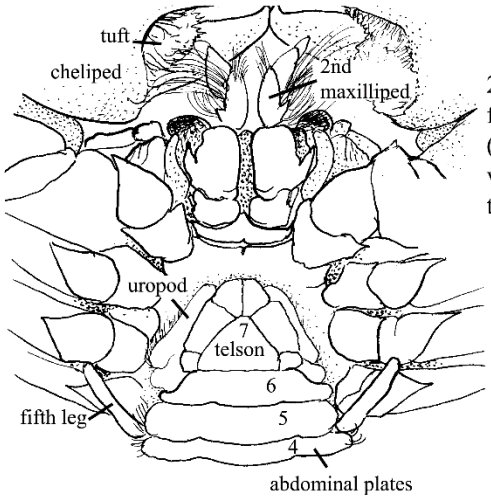
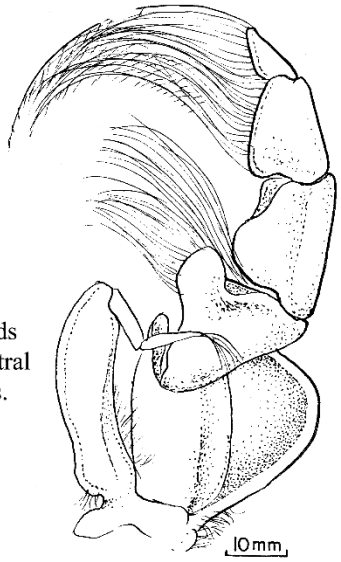
Petrolisthes cinctipes



1. *Petrolisthes cinctipes* x4.5:
actual carapace width 14 mm; body flat, smooth, crab-like; carapace round, abdomen folded under; color blue-brown, iridescent, 2nd maxillipeds red-orange; walking legs striped, merus naked; fifth legs small, elevated.



2. Ventral view x4.5:
folded abdominal plates (4-7 shown); telson, uropods visible; chelipeds with ventral tuft of hair between fingers.



3. Second maxilliped x12:
highly developed articles; long, fine hairs; bright red-orange.

cinctipes, Kuris et al. 2007) (Fig. 1). A short tuft of hair between fingers present ventrally, but chelae are generally hairless (Figs. 1, 2). Merus with conspicuous lobe on anterior margin. (Wicksten 2011).

Abdomen (Pleon): Abdomen symmetrical, short and permanently folded under thorax. Seven abdominal plates (*Petrolisthes*) (Figs. 1, 2).

Telson & Uropods: Seventh plate of telson forms tail fan (Fig. 2). Uropods attached to abdominal segment five.

Sexual Dimorphism: Not obvious superficially. Inside telson, males have single pleopods on abdominal plate two and females have long, branched pleopods on plates 3–5 (not shown).

Possible Misidentifications

Porcelain crabs (Porcellanidae) are flattened dorso-ventrally and are often found in small cracks and crevices. Their third maxillipeds bear long setae, which they use to filter feed and their fifth walking legs are modified into brushes for grooming. There are two genera of porcelain crabs in our area, *Petrolisthes* and *Pachycheles.* Members of the *Pachycheles* have a thick, rough body and chelae, chelae are unequal, tuberculate or granular and hairy, not smooth. Furthermore, the carpus of the chela is as long as broad, not longer than broad as in *Petrolisthes.* There are three local species: *P. holosericus*, *P. pubescens* and *P. rudis* (Kuris et al. 2007).

Petrolisthes species, on the other hand, have a flattened body and chelae, chelae of equal size with carpus longer than it is wide. *Petrolisthes cinctipes* is recognizable by characteristics of the cheliped carpus. The carpus has a long anterior lobe that extends more than 1/4 total carpus length, is smooth and hairless and with margins that converge distally (Kuris et al. 2007). Five *Petrolisthes* species are reported to occur from central California to Oregon including *P. cinctipes*, *P. cabrilloi, P. eriomerus*, *P. manimaculis* and *P. rathbunae*.

Of those, *P. eriomerus* is superficially quite like *P. cinctipes* (Kozloff 1993). This crab lives under rocks in gravelly substrates and is a little smaller than *P. cinctipes*. The carpus of the chelipeds in *P. eriomerus* is twice as long as wide (not 1 1/2 times as long) and the carpus margins are parallel, not converging. Also, there is no prominent lobe at the inner angle and the carpus has scattered tubercules, not a finely granulated surface as in *P. cintctipes*. Ventrally, the outer edge of the maxillipeds in *P. eriomerus* is bright blue, not red orange (Kozloff 1993; Kuris et al. 2007). These two species exhibit a non-overlapping vertical distribution, where *P. eriomerus* occurs in the low intertidal and *P. cinctipes* is found in the mid to high intertidal (Jensen and Armstrong 1991).

P. cabrilloi, *P. manimaculis* and *P. rathbunae* are all reported from California: *Petrolisthes cabrilloi* from Morro Bay, California south to Baja California, Mexico and apparently replaces populations of *P. cinctipes* south of Point Conception, California; *P. manimaculis* from Bodega Bay, California south to Baja California, Mexico; *P. rathbunae* from Monterey, California to Isla Guadalupe, Mexico (Wicksten 2011).

Ecological Information

Range: Type locality is erroneously indicated as in Hawaii, but is likely to be near Monterey, California (Wicksten 2011). Known range includes British Columbia to Point Concepcion, California and also islands offshore of southern California, and Baja California (Haig 1960).

Local Distribution: Outer, more marine portions of large estuaries. Occurs locally in Coos Bay (e.g. Pigeon Point) and in Netarts Bay.

Habitat: Protected, semi-protected rocky coasts under rocks and amongst mussel beds (Ricketts and Calvin 1971; Kuris et al. 2007). Prefers open shores and clear water (Haig 1960) and is not tolerant of sand and silt (Jensen and Armstrong 1991; Wicksten 2011).

Salinity: Collected at salinities of 30.

Temperature: A mid to high intertidal species, *P. cinctipes* is exposed to a wide range of temperature (0–32˚C, Stillman and Somero 2000). Recent research involving physical factors associated with climate change has used *P. cinctipes* as a model organism (e.g. Somero 2010). Stress by thermal variation, more than other physical factors (e.g. pH, salinity), negatively effects *P. cinctipes* (Paganini et al. 2014). However,

when acclimated for a short period of time (6 hrs), *P. cinctipes* can increase thermotolerance (Ronges et al. 2012). Research involving elevated pCO2, salinity and lower pH, all of which simulate predicted physical changes associated with climate change, have focused on *P. cinctipes* life-history stages (e.g. Miller et al. 2014). Long exposure (40 d) to low pH reduced juvenile survival and heart rate. Furthermore, embryonic volumes do not increase at a normal developmental rate when exposed to lower pH (Ceballos-Osuna et al. 2013).
Tidal Level: Mid and upper tidal levels and almost exclusively littoral (Haig 1960). Found only at shore stations and not by dredging (San Francisco Bay, Schmitt 1921).
Associates: Associates include mussels, tunicates, sponges, nudibranch *Onchidoris*, chiton *Mopalia*, shore crabs *Hemigrapsus*, *Cancer oregonensis*, predatory gastropod *Nucella*, and the sea star *Pisaster ochraceus*.
Abundance: Very common (Haig 1960) (up to 860 individuals per m2, Monterey, California) (Barnard et al. 1980). When found, *P. cinctipes* is usually abundant (MacGinitie and MacGinitie 1949; Kuris et al. 2007).

Life-History Information

Reproduction: Females ovigerous every month of the year but April, May, September, October and November (Haig 1960; Barnard et al. 1980) and evidence shows that multiple males (1–3) may contribute to each brood (Toonen 2004). In Coos Bay, March is the month in which the greatest number of females are found with developing young. Eggs are a little over 800 µm in diameter, deep scarlet to maroon when extruded and become brownish red as they advance developmentally (Gonor and Gonor 1973a; Barnard et al. 1980).
Larva: *Petrolisthes cinctipes* larvae were described by Gonor and Gonor (1973a, b). Development proceeds via two zoeal larval stages and a filter feeding megalopa, each marked by a molt (Puls 2001). Porcelain crab zoea are recognizable as larval stages by their elongate anterior and posterior carapace spines (see Fig. 53.1-3, Harvey et al. 2014; Puls 2011; Wicksten 2011) and have been described as "preposterous unicorns" (Ricketts and Calvin 1971) with a long spine to discourage predators. Other characters of zoeal morphology include a telson posterior margin that is rounded and with long plumose setae. *Pachycheles* and *Petrolisthes* species can be distinguished by the presence of terminal brushes on telson setae, in that *Pachycheles* species have only two and *Petrolisthes* species have brushes on all setae (Puls 2001). The megalopa of *Petrolisthes* species have long, slender chelipeds that are dorso-ventrally flattened (as in adults) and *P. cinctipes* megalopae have a cheliped carpus with a single spine on the inner margin and an inconspicuous central notch in posterior margin of the telson (Puls 2001). Recently molted megalopae are thigmotactic, settlement is gregarious and individuals remain in high-density aggregations into adulthood (Jensen 1989, 1991; Donahue 2004). Larval settlement was not effected by upwelling conditions, and instead larval abundance increased prior to spring tides, suggesting tidal transport shoreward for settlement (Mace and Morgan 2006). *Petrolisthes cinctipes* larvae do not vertically migrate and maintain their position in nearshore habitats by remaining at depth, where water flow would not push them offshore (Shanks 2009; Miller and Morgan 2013).
Juvenile: Following settlement, megalopae lose the ability to swim as their pleopods degenerate and their body color changes (Fig. 6, Jensen 1991).
Longevity:
Growth Rate: Growth occurs in conjunction with molting. In pre-molting periods the epidermis separates from the old cuticle and a dramatic increase in epidermal cell growth occurs. Post-molt individuals will have soft shells until a thin membranous layer is deposited and the cuticle gradually hardens. During a molt decapods have the ability to regenerate limbs that were previously autotomized (Kuris et al. 2007). Porcellanid crabs readily autotomize their chelipeds, to avoid predation, and *Petrolisthes cinctipes* is no exception (Kuris et al. 2007) and autotomy tends to be more common among female and small individuals (Wasson and Lyon 2005). For complete molt

staging scheme in *P. cinctipes*, see Kurup 1964b.

Food: A filter feeder that sifts plankton and detritus from water with fan-like second maxillipeds. Feeding behavior evoked by presence of amino acids, sugars (Hartman and Hartman 1976). Despite their mobility, *Petrolisthes cinctipes* is a gregarious species, and increases in conspecific density have been shown to reduce growth rate and feeding frequency (Donahue 2004).

Predators:

Behavior:

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