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A new species of *Nephropsis* (Decapoda: Nephropidae) from the Late Oligocene of the Lincoln Creek Formation

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Abstract

A new species of *Nephropsis*, *N. larryi* new species, from the Lincoln Creek Formation of Washington, USA, differs from all previously described species of *Nephropsis*. The Lincoln Creek Formation of Washington, USA, was deposited in a continental shelf environment, preserving many genera of invertebrates, including lobsters, which have not been formally described from the formation. *Nephropsis* is known from eighteen extant species and only one other fossil species. The fossil species, *Nephropsis midwayensis* Rathbun, 1935, is from the Paleocene of Gulf Coastal USA. Additionally, nearly every other species of *Nephropsis* is known from either the Atlantic Ocean or the Indo-West Pacific Ocean, with only one being native to the Western Pacific coast of North America.

Key words: lobster, Lincoln Creek Formation, Washington, Oligocene, crustacean

1. Introduction

The Upper Eocene (34–34.5 Ma) to Lower Miocene (23 Ma) Lincoln Creek Formation in Washington, USA, was deposited in a continental shelf environment, rife with volcanic activity and resulting in the tuffaceous siltstones and sandstones that now comprise much of the formation (Beikman et al., 1967; Prothero et al., 2008). In the Lincoln Creek Formation, the Knappton locality at which the fossil herein described was collected is Chattian in age, and the formation as a whole is Eocene to Early Miocene in age (Amano and Kiel, 2007; Fierstine, 2005; Kočí et al., 2022; Mayr and Goedert, 2017; Peckmann et al., 2002; Smrzka et al., 2015). The environment during the Oligocene in the Lincoln Creek Formation was a moderately deep sea (~350 m), with cool waters, characterized by methane seep deposits (Goedert and Peckmann, 2005; Kiel, 2010; Kiel et al., 2012). The fossil fauna of the Lincoln Creek Formation is dominated by mollusks and annelids (Goedert et al., 2000). Fossil decapods are known from the formation, with crabs being the most common (Feldmann et al., 2018) (Table 1). The Lincoln Creek Formation contains roughly thirteen genera of fossil decapods, five of which are extinct, and five of the extant genera present are now absent from the Pacific Coast of North America in the Holocene.

Some reported fossil decapods from the Knappton locality of the Lincoln Creek Formation include species of *Pulalius* Schweitzer et al., 2000, and *Callianassa* Leach, 1814 sensu lato (Rathbun, 1926; Paleobiodb.org). Fossil lobsters are known from the Pacific coast of North America, belonging to the genus

Hoploparia M'Coy, 1849 (Schweitzer et al., 2003), in the same family, Nephropidae, as *Nephropsis* Wood-Mason, 1872. *Nephropsis occidentalis* Faxon, 1893, is the sole extant species of the genus that is native to the East Pacific. The discovery of a nephropid lobster in the Lincoln Creek Formation significantly extends the northern range of Pacific coast lobsters and adds a new species of *Nephropsis* to the North American decapod fossil fauna. The description of this new species from the Oligocene of North America in the Lincoln Creek Formation forms the basis for this work.

2. Methods

The specimen was donated by Robert Manley of Mount Angel, Oregon. Photographic illustrations were prepared using a Nikon D3100 camera with an AF-S micro Nikkor 60 mm lens. Contrast and brightness were optimized in Adobe Photoshop 27.4 before being composed in Adobe Illustrator 30.2.1. Abbreviations for morphological features of the cephalothorax follow Holthuis (1974).

3. Systematic paleontology

Order Decapoda Latreille, 1802
Infraorder Astacidea Latreille, 1802
Superfamily Nephropoidea Dana, 1852
Family Nephropidae Dana, 1852

Genus *Nephropsis* Wood-Mason, 1872

Type species: *Nephropsis stewarti* Wood-Mason, 1872, by monotypy.

Included species: *Nephropsis acanthura* Macpherson, 1990; *N. aculeata* Smith, 1881; *N. agassizii* A. Milne-Edwards, 1880; *N. atlantica* Norman, 1882; *N. carpenteri* Wood-Mason, 1885; *N. ensirostris* Alcock, 1901; *N. grandis* Zarenkov, 2006; *N. holthuisi* Macpherson, 1993; *N. larryi* new species (extinct); *N. malhaensis* Borradaile, 1910; *N. midwayensis* Rathbun, 1935 (extinct); *N. neglecta* Holthuis, 1974; *N. occidentalis* Faxon, 1893; *N. pygmaea* Chang et al., 2020a; *N. rahayuae* Chang et al., 2020b; *N. rosea* Bate, 1888; *N. serrata* Macpherson, 1993; *N. stewarti* Wood-Mason, 1872; *N. suhmi* Bate, 1888; *N. sulcata* Macpherson, 1990.

Diagnosis: Narrowly elongate, triangular rostrum with no ventral spines, may have one or two pairs of lateral spines, directed outward and forward. Carapace with distinct supraorbital and a major antennal spine; distinct cervical, postcervical, and hepatic grooves, antennal groove present; chelipeds equal; uropods extend dorsally and terminate in a spine (adapted from Holthuis, 1974).

Discussion: Holthuis (1974) summarized work done on *Nephropsis* and other nephropid genera. The fossil specimen is consistent with the general description of the genus in having a narrowly elongate, triangular rostrum with a pair of lateral spines, which are directed outward and forward. The preserved carapace has a distinctive supraorbital spine and distinct cervical, postcervical, and hepatic grooves. The chelipeds are equal. The uropods extend dorsally and terminate in a spine. The carapace is granular in ornamentation. This species is small for the family but typical for the genus (Holthuis, 1974). Assignment of this specimen to *Nephropsis* can be made with confidence, as the groove patterns described differentiate this specimen from *Hoploparia* and align with the groove patterns diagnostic of *Nephropsis*. The groove patterns of the fossil specimen (Figs. 1A–1C) align closely with those of modern species such as *N. rosea* (Figs. 2A, 2B). The modern *Nephropsis* species are characterized by features such as overall body size, the presence of pleonal spines, and deeply impressed groove patterns, which align with that of the fossil specimen, and are exemplified in the comparison specimen (Figs. 2A, 2B). The similarities in morphology confirm placement of the fossil species within the genus *Nephropsis.*

Tshudy (1993) and Feldmann et al. (2016) provided a definition of the genus *Hoploparia* to which the characteristics of the new specimen are compared. This new species differs from the known Nephropidae species in the surrounding area, *Hoploparia tshudyi* Schweitzer and Feldmann, 2001, and *Hoploparia riddlensis* Feldmann, 1974. The antennal groove of the new species extends dorsally more than that of both species of *Hoploparia* discussed. Additionally, the postcerival groove of both species of *Hoploparia* extend anteriorly in a semicircular arc past the connection to the hepatic groove, unlike the new species, in which the postcervical groove and hepatic groove are

joined together. Further distinctions can be made in regard to the ornamentation of the carapace of the new specimen, which possesses a granular surface unlike the smooth surface of the described species of *Hoploparia.*

***Nephropsis larryi* new species**

(Fig. 1)

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Diagnosis: *Nephropsis* with very well developed cervical and postcervical grooves and deeply impressed antennal and hepatic grooves; postcervical groove extends dorsally at a 45-degree angle, changing to a 90-degree angle dorsally. Rostrum possesses a distinctive pair of large dorsal spines, and large supraorbital spine. Carapace ornamentation granular.

Description: Medium size for genus, possessing pair of large lateral rostral spines (3) near the termination of rostrum (Fig. 1B). Medial spine (5) present but broken. Supraorbital spine (6) preserved as deep channel in counterpart (Fig. 1C). Antennal spine (10) poorly preserved as channel in counterpart piece, followed by antennal carina (A). Granular cephalic surface with pitting on the internal mold of the carapace. Pitting is small and best preserved in the posterior margin of the cephalothorax (Figs. 1A, 1C).

Antennal groove (b) deeply impressed, extending dorsally towards orbit. Hepatic groove (b') deeply impressed. Cervical groove (e-e') deeply impressed, extending from dorsal margin and curving ventrally into the hepatic groove. Postcervical groove (c) deeply impressed, extends dorsally, beginning ventrally at a 45-degree angle and changes to a near 90-degree angle extending dorsally. Posteromarginal groove (p.m.) strongly developed, terminating at the posteroventral corner.

Pleon with six somites preserved; telson and uropods not preserved. Pleonite surfaces smooth, with a swelling appearing ventrally and above the pleonal spines, terminating ventrally in sharp spine-like tip. Pleonal spines shorten from one pleonite to the next posteriorly. Basal article of left cheliped preserved. Merus broadens slightly distally, granular texture. Carpus stout, slightly longer than high, granular texture. Propodus of first cheliped partially preserved, broadens distally, palm longer than fingers, dactylus partially preserved.

Measurements: The entire preserved specimen is approximately 30 mm in length; total carapace length including rostrum, 18.14 mm; length from base of orbit to posterior margin, 12.48 mm; length from base of orbit to postcervical groove, 7.80 mm; carapace height, 7.16 mm, measured at postcervical groove. Total length from rostrum to broken end of pleonal somite 6, 31.8 mm. Rostrum (R) medium length for the genus, extending 3.9 mm anteriorly from dorsal margin of the carapace. Antennal groove (b) deeply impressed, extending dorsally towards orbit, 1.9 mm long. Hepatic groove (b') deeply impressed, 1.5 mm long. Cervical groove (e-e') deeply impressed, extending from dorsal margin 1.4 mm and curving ventrally into the hepatic groove. Postcervical groove (c) deeply impressed, extends dorsally, beginning ventrally at a 45-degree angle and extending 4.2 mm where it changes to a near 90-degree angle extending dorsally for 2.6 mm.

Etymology: The trivial name honors the late Stephen Hillenburg, who contributed to exposing the field of marine biology to many through entertainment. Specifically, the name is in reference to the character Larry the Lobster from Hillenburg's animated series, *SpongeBob SquarePants*.

Types: The holotype, and sole specimen, USNMPAL 804226, is deposited in the United States National Museum of Natural History, Washington DC.

Locality and stratigraphic position: The specimen was collected at Knappton, Pacific County, Washington, USA, latitude 46.284167, longitude 123.804722. Lincoln Creek Formation, Knappton locality (Mindat; Ralph et al., 2025; paleobiodb.org).

Discussion: This species is represented by one specimen, the holotype, which consists of an articulated cephalothorax and pleon consisting of six pleonites but absent the telson and uropods, as well as preserving some elements of the first cheliped. The pleon is fully extended. The cuticle is strongly fractured in both the cephalothorax and the pleon. The exocuticle exhibits a granular pattern.

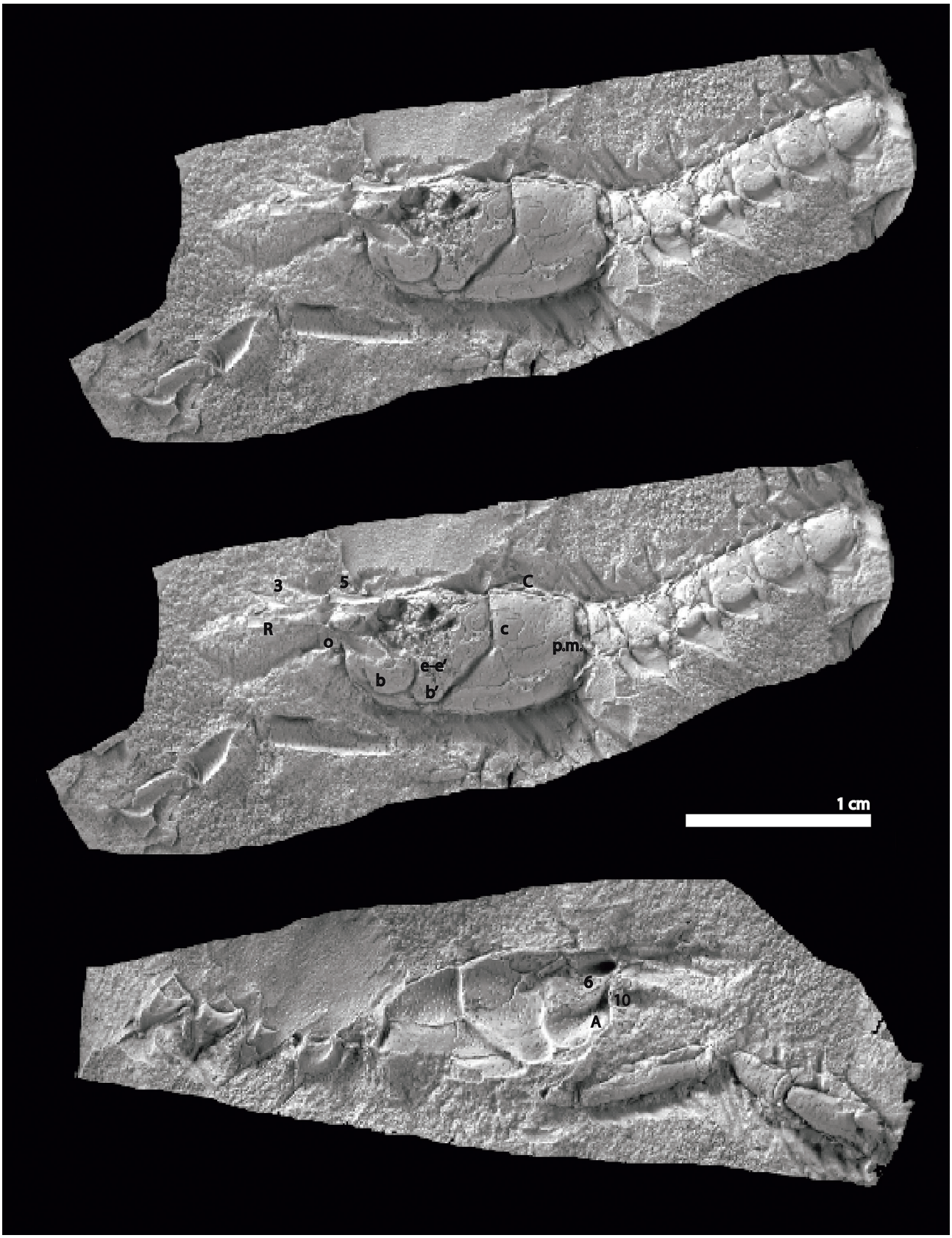

Fig. 1. ***Nephropsis larryi*** **new species**. A–C, holotype, USNMPAL 804226, (A) left lateral view of the carapace, pleon, and left cheliped; (B) carapace with morphology labeled; (C) right lateral view of carapace and pleon counterpart. Abbreviations: A = antennal carina, b = antennal groove, b' = hepatic groove, C = median carina, c = postcervical groove, e-e' = cervical groove, o = orbit, p.m. = postmarginal groove, R = rostrum, 3 = lateral rostral spine, 5 = median spine, 6 = supraorbital spine, 10 = antennal spine. Scale bars = 1 cm.

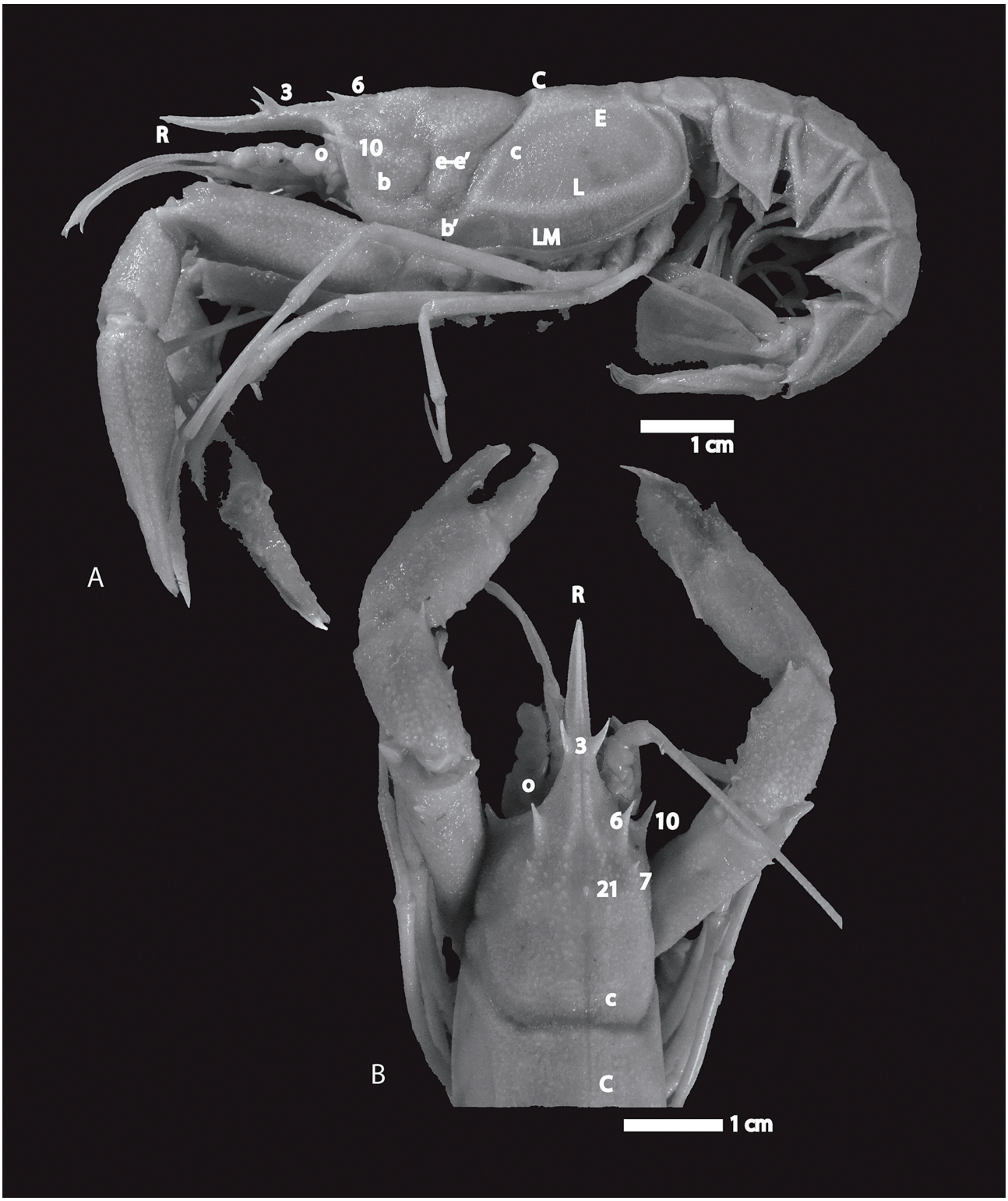

Fig. 2. ***Nephropsis rosea*** (Bate, 1888). A–B, wet specimen, USNM 181773, (A) Left lateral view of carapace, pleon, and chelipeds with labeled morphology; (B) dorsal view of cephalothorax with morphology labeled. Abbreviations: b = antennal groove, b' = hepatic groove, C = median carina, c = postcervical groove, E = intermediate carina, e-e' = cervical groove, L = lateral carina, LM = lateromarginal carina, o = orbit, p.m. = postmarginal groove, R = rostrum, 3 = lateral rostral spine, 6 = supraorbital spine, 7 = postsupraorbital spine, 10 = antennal spine, 21 = gastric tubercle. Scale bars = 1 cm.

Placement of this new species in *Nephropsis* is confirmed by its having a typical nephropid form and possessing a long rostrum with lateral rostral spines, a medial spine, a supraorbital spine, a very well

developed postcervical groove that extends dorsally at a 45 degree angle before it changes to a near 90 degree angle and continues dorsally, the propodus of the first cheliped with palm longer than fingers, and pleura that end in a sharp, spine-like tip that is not as exaggerated as on related genera like *Metanephrops* (Wood-Mason, 1872). The rostrum possesses a large lateral spine, as well as a pair of medial spines posterior to the rostrum. A large supraorbital spine is present.

The fossil specimen bears a strong resemblance to the modern species *Nephropsis rosea* (Figs. 2A, 2B). Close comparisons can be made between *N. larryi* (Fig. 1) and *N. rosea* (Fig. 2) in regard to appearance and nature of grooves and spines. The deeply impressed grooves present on the fossil specimen appear in the modern species, with slight alterations to the angle at which the postcervical groove extends dorsally. Additionally, the nature of the spines on the fossil specimen closely resembles that of the modern analogue, with the addition of a medial spine and no visible evidence of a postsupraorbital spine on the fossil specimen. The fossil specimen also preserves the pleonal spines, which appear in many modern *Nephropsis*, including *N. rosea* (Fig. 2A).

Among the modern species of *Nephropsis,* five inhabit the Atlantic, seven are known from the Indo-West Pacific, and only one is known from the eastern Pacific (Holthuis, 1974; obis.org). *Nephropsis* does not have an extensive fossil record either, with only a claw fragment known from *Nephropsis midwayensis* (s, 1935), from the Danian (66–61.6 Ma) of Wilcox County, Alabama (Klompmaker et al., 2025). The new species comes from between the Late Eocene and Early Miocene, most likely the Chattian of the Late Oligocene. The age of the specimen and the location, as well as numerous physical features that distinguish it from others in its genus, support the assignment to a new species. The genus now contains twenty species, eighteen of which are modern, and two fossil species, which places the range from Eocene to Holocene, primarily found in the Atlantic and Indo-West Pacific regions.

Table 1. Lincoln Creek Formation and nearby Astoria Formation decapod genera and extinction status, as well as the presence of extant genera in the Holocene of the Pacific coast of North America. Fossil occurrences gathered from Rathbun (1926), Nyborg and Vega (2008), Feldmann et al. (2018), Nyborg and Garassino (2015), and Nyborg et al. (2016). Modern occurrences gathered from obis.org (accessed March 31, 2026).

Genera	Status	Modern Presence in Region
Branchioplax Rathbun, 1916	Extinct	-
Callianassa Leach, 1814	Extant	Absent
Callianopsis de Saint Laurent, 1973	Extant	Present
Carcinus Leach, 1814	Extant	Present
Lophomastix Benedict, 1904	Extant	Absent
Macroacaena Tucker, 1998	Extinct	-
Macrocheira De Haan, 1839	Extant	Absent
Maeandricampus Schweitzer and Feldmann, 2002	Extinct	-
Megokkos Schweitzer and Feldmann, 2000	Extinct	-
Munida Leach, 1821	Extant	Present
Neocallichirus Sakai, 1988	Extant	Absent
Nephropsis Wood-Mason, 1872	Extant	Absent
Pulalius Schweitzer et al., 2000	Extinct	-
Raninoides H. Milne-Edwards, 1837	Extant	Absent

4. Discussion

The list of *Nephropsis* species contains primarily extant members that are native to the Atlantic and Indo-West Pacific regions (obis.org). Only one species, *N. occidentalis* Faxon, 1893, is known from the East Pacific region today, found on the west coast of Mexico (Holthuis, 1974; obis.org). Additionally, there is only one species known from the fossil record for *Nephropsis*. This places the new species in two unique thresholds for the genus. Modern species are found in offshore to deep-sea environments, typically ranging from 200 to 2000 meters in depth. The paleoenvironment of the Lincoln Creek Formation during the Oligocene was a moderately deep-sea, 300 to 800 meters in depth, cool to cold water (Peckmann et al., 2002; Qu et al., 2017), and was described as a continuous marine shelf and slope (Kočí et al., 2022). The paleoenvironment of the Lincoln Creek Formation matches that of the modern environment in which *Nephropsis* species are found, but *Nephropsis* species are absent on Pacific coastal USA, the only occurrences being in Mexico (Faxon, 1893).

The presence of a *Nephropsis* species in the Northern East Pacific had been undocumented in both the fossil record and modern surveys. Its absence may be attributed to multiple factors: insufficient fossil material, insufficient modern surveys of the Pacific West coast of North America, or an absence that aligns with that of many other East Pacific species after the Oligocene. A similar biogeographic distribution is seen in groups such as Raninoidea and Homoloidea (Shaffer and Schweitzer, 2024) and many other invertebrate groups known from the fossil record of the Pacific coast of North America (Table 1). This suggests that there is a pattern of disappearance of genera in the Oligocene to Miocene decapod fauna in the Pacific Coast of North America.

The shift in biodiversity, especially among deep-sea ecosystems, is likely a result of global cooling during the Oligocene-Miocene boundary time in which deep-sea environments became cooler and shifted in both carbon and oxygen concentrations (Beddow et al., 2016). The Lincoln Creek Formation and the nearby Astoria Formation, which is very close in age (Berglund and Goedert, 1992; Kuechler et al., 2012), contain thirteen known genera of fossil decapods, five of which are now extinct (Paleobiodb.org; DecaNet) (Table 1), and five of the remaining genera are extant but absent in the Holocene from the Pacific Coast of the US (obis.org). This extinction pattern may indicate a shift in conditions around the Oligocene-Miocene transition. Possible drivers for localized extinction may include the transgression and regressions of the Pacific Ocean during the Middle Miocene, as this would result in changes in productivity, carbon and oxygen levels, and temperature (Woodruff and Savin, 1985). Additionally, changes in paleobathymetry during the Late Oligocene to Early Miocene have been linked to changes in other faunal diversity distributions, such as those of cetaceans (Goedert et al., 2007). Paleobiogeographic distributions of the decapod fauna have been analyzed from the Pacific Northwest and align with some of the proposed drivers for faunal changes. Pacific Northwest decapods may have been isolated as seaways started to close (Schweitzer, 2001). Further, more comprehensive research into the extinction patterns of decapod genera in the Eastern Pacific from the Paleogene to the present may provide more insight into the decline of decapod genera in this region.

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