JOURNAL OF CRUSTACEAN BIOLOGY, 28(4): 686–694, 2008

BICORNISRANINA BOCKI, N. GEN., N. SP. (DECAPODA: RANINIDAE) FROM THE CRETACEOUS OF VANCOUVER ISLAND, BRITISH COLUMBIA, CANADA

Torrey Nyborg and John Fam

(TN, correspondence) Department of Earth and Biological Sciences, Loma Linda University, Loma Linda, California 92350 U.S.A. (tnyborg06@llu.edu)
(JF) 1404-1199 Eastwood St., Coquitlam, BC, Canada V3B 7W7 (jfama@alumni.sfu.ca)

ABSTRACT

A new genus and species of raninid crab, *Bicornisranina bocki*, is described from the Upper Cretaceous Haslam and Pender formations of Vancouver Island, British Columbia, Canada. *Bicornisranina bocki* (Raninidae: Raninoidinae) shares similar characteristics with other genera within Raninidae, including a bifid anterolateral spine, as seen in *Rogueus*, and a similar frontal spine conformation as seen in *Raninoides*. Although *B. bocki* shares morphological characteristics with other genera within Raninidae, *B. bocki* possesses a distinct sternum that sets it apart and warrants establishment of a new genus. With the occurrence of *Bicornisranina* from lower Campanian rocks of Vancouver Island, the range of Raninoidinae is confidently extended into the Cretaceous.

KEY WORDS: *Bicornisranina*, Raninidae, Vancouver Island, Canada, Haslam Formation, Cretaceous

INTRODUCTION

Fossil decapod crustaceans from Vancouver Island, British Columbia, Canada were first described in the late 1800's and early 1900's (Whiteaves, 1884, 1885, 1895, 1903; Woodward, 1896, 1900). Rathbun (1926) reported fossil crabs from the west coast of North America including British Columbia. Jeletzky (1973) reported crab occurrences on islands adjacent to Vancouver Island. Feldmann and McPherson (1980) summarized the known occurrences of fossil decapods from Canada. Ludvigsen and Beard (1994) illustrated several decapod taxa from Vancouver Island including *Rogueus* sp. from Northwest Bay herein renamed *Bicornisranina bocki*. However, the crab was not systematically described, and the affinity of *B. bocki* to *Rogueus* Berglund and Feldmann, 1989 was based solely upon the similarities of the bifid anterolateral spine. Recently Schweitzer et al. (2003) described a new family, three new genera, and eight new species from Vancouver Island. Vancouver Island has proven to have a very robust fossil decapod crustacean history (Schweitzer et al., 2003). More collecting and additional taxonomic studies are needed to fully understand the role Vancouver Island played in the origination and dispersal of fossil decapod crustaceans both within the eastern North Pacific Ocean and the world.

MATERIALS AND METHODS

Specimens of *Bicornisranina bocki* n. gen., n. sp., were collected from two formations, which are part of the Upper Cretaceous Nanaimo Group of southwestern British Columbia (Haggart, 1991; Mustard, 1994) (Figs. 1, 2). The age of the Nanaimo Group ranges from Turonian to Maastrichtian (Haggart, 1991; Mustard, 1994) (Fig. 2). Eleven formations (Fig. 2) composed of mudstones, fine sandstones, and sandstone-conglomerates deposited primarily in an outer neritic to bathyal marine setting as submarine fan deposits but with some nearshore deposits have been included within the Nanaimo Group (Mustard, 1994). The Nanaimo Group crops out along the northeastern coastline of Vancouver Island extending from the Campbell River in the north to Saanich Peninsula in the south. It is also exposed in the adjacent Gulf Islands and northern San Juan Islands, Washington, USA (Fig. 1).

Specimens of *Bicornisranina bocki* were collected from shoreline outcrops at Northwest Bay, Vancouver Island, British Columbia at lat. 49°18′13.8″N, long. 124°12′86.7″W (Fig. 1). The section at Northwest Bay consists of a medium grained sandstone sequence that is Late Cretaceous in age. Isolated pebbles are found embedded throughout the unit. Numerous concretions ranging in size from 4 cm to 1 m occur within this sequence. Previous workers have assigned this locality to the Haslam Formation (Enkin et al., 2001). The Haslam Formation overlies the lower Santonian to lower Campanian Comox Formation and is overlain by the Extension Formation and in other areas is gradational with the overlying Pender Formation (Fig. 2). Although the lithology of the Haslam Formation is mainly composed of gray mudstone and siltstone, sandstone interbeds have also been documented (Mustard, 1994). The Haslam Formation is believed to be at least 500 m in thickness (Mustard, 1994). Trace fossils, foraminifera, macrofossils, and lithology depict variable outer shelf and slope depositional environments. The sandstones are thought to have been deposited in distal prodelta and outer submarine low-concentration deposits (Mustard, 1994). Because this study is concerned primarily with decapod systematics, both authors concur with the most recent work to assign these rocks to the Haslam Formation.

There are few diagnostic macrofossils at the Northwest Bay locality. Ghost shrimps (Callianassidae) are the most common fossils. The molluscs are quite rare but do include the genus *Sphenoceramus* sp. Vancouver Island Paleontological Museum in Qualicum Beach has a large fragment of an unidentified ammonite from the Northwest Bay locality. Fossil leaves and other carbonaceous material have also been found. Specimens of *Bicornisranina bocki* described herein are extremely rare and known only from a handful of specimens.

Until recently, *Bicornisranina bocki* was only collected from sandstone outcrops at Northwest Bay. Additional specimens have subsequently been collected from the Duncan Bay logging main overpass at kilometer 147 on New Inland Island Highway, near Courtenay, British Columbia, at lat. 49°51′05.9″N, long. 125°13′46.5″W. The rocks of this locality are early Campanian Pender Formation (R. L. M. Ross and D. Meckert, personal communication) (Fig. 2). Fossils collected at this locality occur sporadically in sandy shales, with few diagnostic fossils. The Pender Formation is comprised of up to 300 m of mudstone and siltstone interbedded with occasional sandstone beds (Mustard, 1994). At this locality, the Pender Formation overlies the Haslam Formation, while in other areas the Pender Formation overlies the Extension Formation (Fig. 2). The sequence appears to have been deposited in an outer shelf and upper slope marine environment (Mustard, 1994). Examination of several specimens collected from the New Inland Island Highway corresponds to the morphology of *B. bocki* from Northwest Bay.

Institutional abbreviations used throughout this paper are: GSC, Geological Survey of Canada Eastern Paleontology Division, Ottawa,

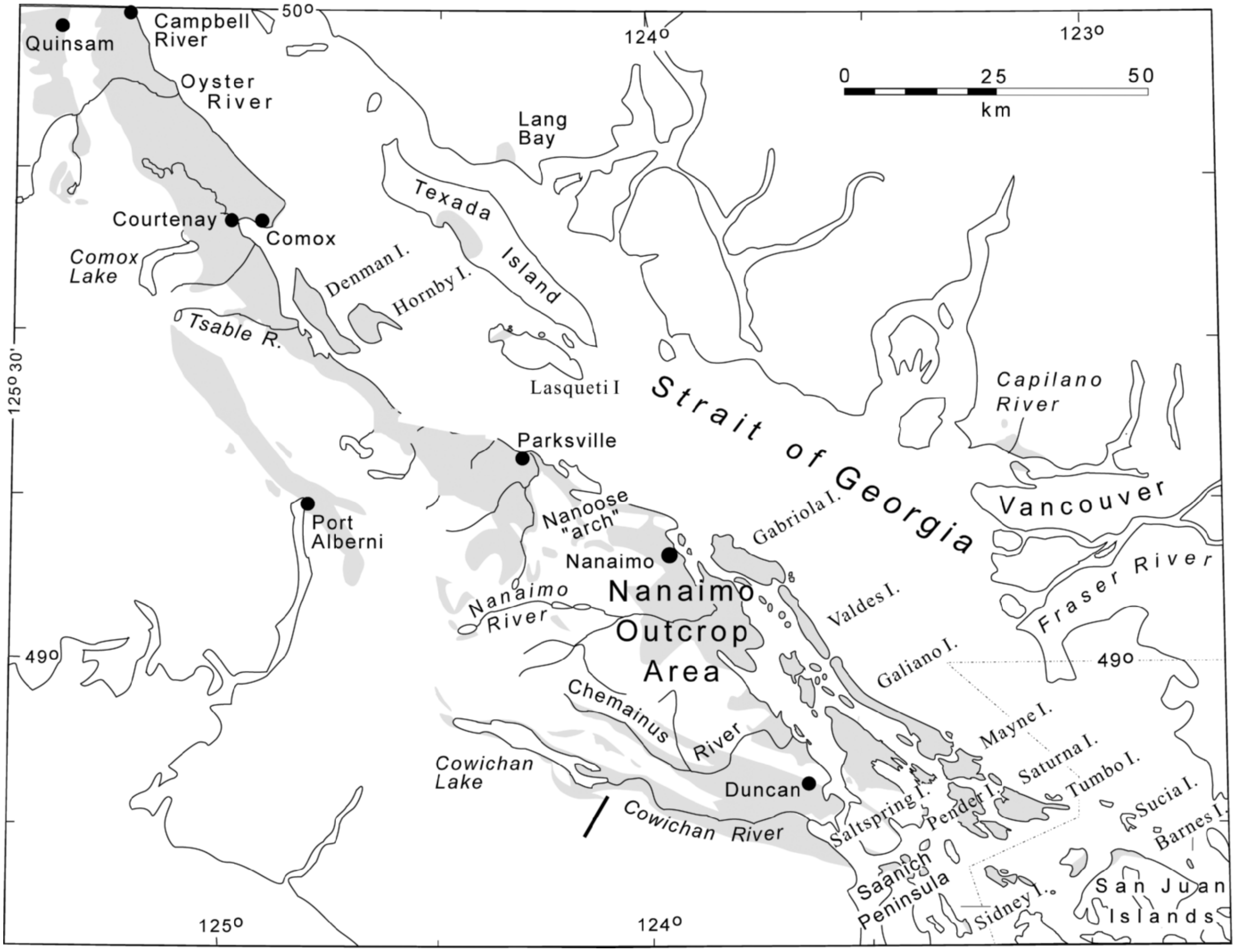

Fig. 1. Location map of study area with geographic names along the eastern shoreline of Vancouver Island, British Columbia, Canada. Gray shaded area represents outcrops of the Nanaimo Group. Adapted from Mustard (1994) and used with permission.

Ontario, Canada; VIPM, Vancouver Island Paleontological Museum, Vancouver Island, British Columbia, Canada; CDM, Courtenay and District Museum Palaeontology Centre, Vancouver Island, British Columbia, Canada; and USNM, United States Museum of Natural History, Washington, D.C., United States.

Systematics

Order Decapoda Latreille, 1802
Infraorder Brachyura Latreille, 1802
Raninoidea De Haan, 1841
Raninidae De Haan, 1841
Raninoidinae Lőrenthey and Beurlen, 1929

Bicornisranina n. gen.

Type Species.—*Bicornisranina bocki*, the sole and included species.

Etymology.—The new genus takes its name from the Latin word "bicornis" meaning two-pronged referring to the bifid anterolateral spine and "ranina" derived from the Latin word for frog (rana). Raninid crabs are often commonly referred to as "frog crabs."

Diagnosis.—Carapace longer than wide, rectangular in outline, widest approximately one-third the distance posteriorly on carapace; fronto-orbital region broad, with well developed rostrum; rostrum bounded on either side by inner-orbital, intra-orbital and outer-orbital spines, fronto-orbital width about two-thirds maximum carapace width; anterolateral margin short, bounded by bifid anterolateral spine; posterolateral margin straight, tapers slightly posteriorly; posterior margin about half maximum carapace width; chelipeds equal in size, manus quadrate, flat. Sternal elements 1-3 fused; sternal element 4 lateral margins weakly concave; sternal element 5 rectangular in outline.

Remarks.—*Bicornisranina* is placed within Raninidae based upon an elongate cephalothorax, a well-developed rostrum, smooth carapace with poorly defined regions, well-developed orbits and flat, equal in size, chelipeds (Tucker, 1995, 1998). Furthermore, *Bicornisranina* is placed into Raninoidinae based upon a fronto-orbital width more than one-half the extreme width of carapace, two orbital fissures, a medial orbital spine, one anterolateral spine and chelipeds with flattened propodus (Tucker, 1995, 1998).

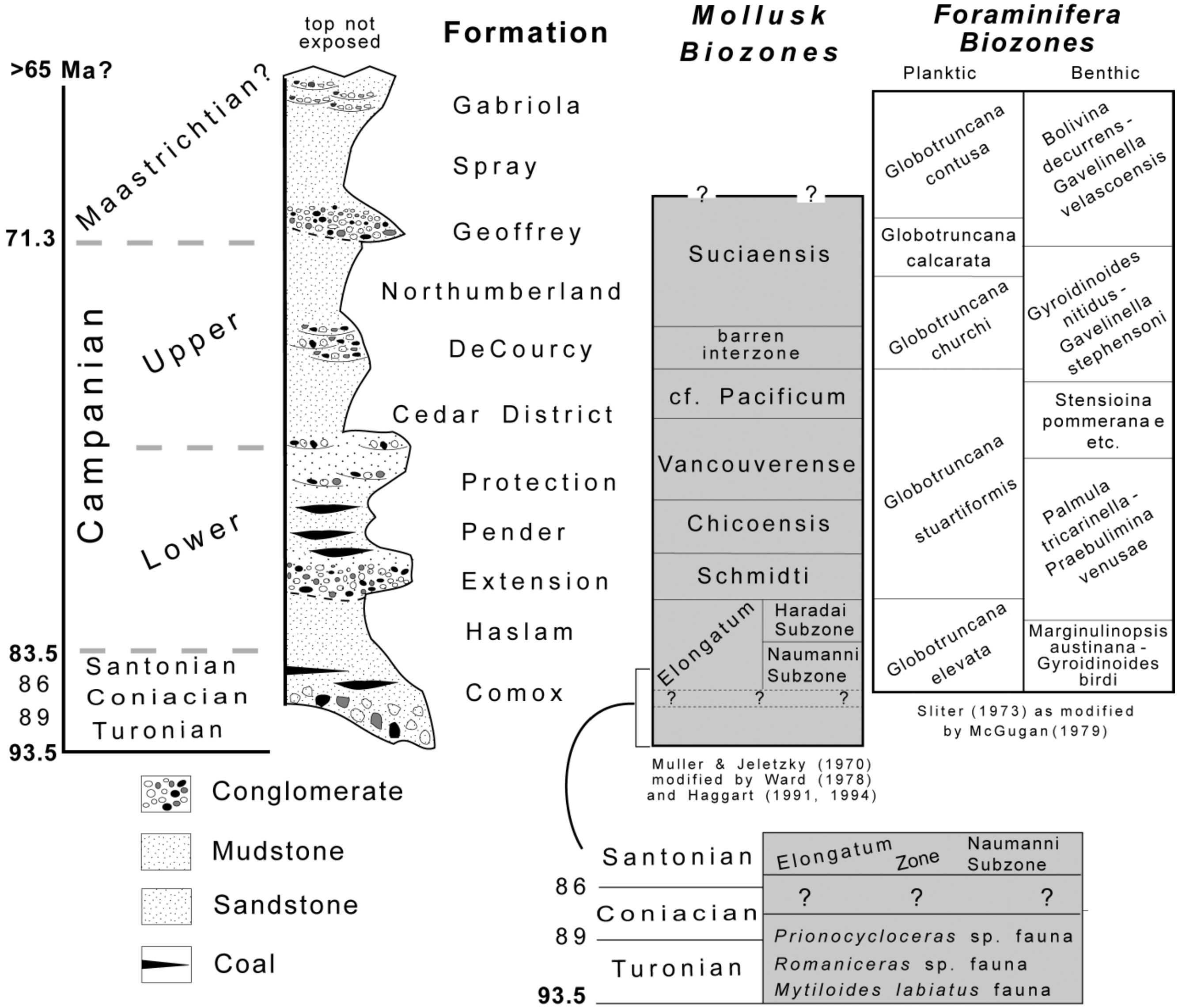

Fig. 2. Stratigraphic column of the Nanaimo Group. Biozone information adapted from Muller and Jeletzky (1970), Sliter (1973), Ward (1978), McGugan (1979), and Haggart (1991, 1994). Eustatic curve from Haq et al. (1988). Adapted from Mustard (1994) and used with permission.

Bicornisranina shares several similar dorsal carapace morphologies with other genera within Raninidae, namely with *Rogueus* and *Raninoides* H. Milne Edwards, 1837 (Fig. 3). *Bicornisranina* has similar frontal spine conformation, same number and position of spines, as seen in *Raninoides* (Fig. 3). However, *Bicornisranina* is widest approximately one-third the distance posteriorly on the carapace whereas in *Raninoides* the extreme width is in the posterior one-half of the carapace (Tucker, 1995). Also all species of *Raninoides* posses a single anterolateral spine that is not bifid as seen in *Bicornisranina*. In addition, the sternum of *Bicornisranina* differs from the sternum of *Raninoides* in having wider fused sternal elements 1-3, reduced lateral extensions on each side of sternal element 5, and *Bicornisranina* lacks the medial sternal groove that is seen on sterna of *Raninoides* spp. (Fig. 4).

Bicornisranina has the same bifid anterolateral spine, which is distinctive in *Rogueus*, but the fronto-orbital region is quite different (Fig. 3). Namely *Bicornisranina* has a well-developed triangular rostrum, inner-orbital, intra-orbital and outer-orbital spines and a fronto-orbital margin width about two-thirds maximum carapace width, whereas *Rogueus* has a rostrum that is rounded with a medial sulcus with no inner-orbital or intra-orbital spines and a fronto-orbital width about three-fourths maximum carapace width (Berglund and Feldmann, 1999). In addition, the *Rogueus* sternum has lateral extensions on either side of sternal element 5 (Berglund and Feldmann, 1999) (Fig. 4), whereas in *Bicornisranina* sternal element 5 is rectangular in outline with very reduced lateral projections (Fig. 4). Therefore, the only similarity between *Bicornisranina* and *Rogueus* are the bifid anterolateral spines. In fact, the two genera are different enough to be separated into two subfamilies, *Bicornisranina* belonging to Raninoidinae Lőrenthey and Beurlen, 1929 and *Rogueus* belonging to Lyreidinae Guinot, 1993.

Psuedorogueus rangiferus Fraaye, 1995 described from the middle Lower Eocene Ager Formation of Spain has a distinct anterolateral spine with "three forwardly directed spinules" (Fraaye, 1995, p. 66) (Fig. 3). *Psuedorogueus* differs from *Bicornisranina* in not only having a distinctly different anterolateral spine, but also a intra-orbital spine that is about half the length of the intra-orbital spine as seen in *Bicornisranina* and a deeper and wider fissure between the outer-orbital and anterolateral spines (Fig. 3). The sternum of *Psuedorogueus* is unknown so comparison at this time is not possible.

A review of the genera within Raninidae where the sternum is known and illustrated includes: within Ranininae De Haan, 1841, the genera *Ranina* Lamarck, 1801 (Fig. 4A) and *Lophoranina* Fabiani, 1910 (Fig. 4B); within Cyrtorhinae Guinot, 1993, the genus *Cyrtorhina* Monod, 1956 (Fig. 4C); within Lyreidinae Guinot, 1993, the genera *Lyreidus* De Haan, 1841 (Fig. 4D), *Raninella* A. Milne Edwards, 1862 (Fig. 4E), *Lysirude* Goeke, 1985 (Fig. 4F), *Rogueus* Berglund and Feldmann, 1989 (Fig. 4G), and *Macracaena* Tucker, 1995 (Fig. 4H); within Notopodinae Serène and Umali, 1972, the genera *Notopus* De Haan, 1841 (Fig. 4I), *Cosmonotus* White, 1847 (Fig. 4J), *Ranidina* Bittner, 1893 (Fig. 4K) and *Ranilia* H. Milne Edwards, 1837 (Fig. 4L); within Notopocorystinae Lőrenthey and Beurlen, 1929, the genera *Notopocorystes* M'Coy, 1849 (Fig. 4M), *Cretacoranina* Mertin, 1941 (Fig. 4N), and *Eucorystes* Bell, 1863 (Fig. 4O); within Raninoidinae Lőrenthey and Beurlen, 1929, the genera *Quasilaeviranina* Tucker, 1995 (Fig. 4P), *Raninoides* H. Milne Edwards, 1837 (Fig. 4Q, R), *Notosceles* Bourne, 1922 (Fig. 4S), and *Bicornisranina* reported herein (Fig. 4T) (also refer to comparison drawings of sterna given by Guinot, 1993; Tucker 1995, and the sternum descriptions of Davie, 2002). One feature not seen on any other known sterna of Raninidae is the distinct groove that separates the 1-3 fused sternal element from sternal element 4 in *Bicornisranina*.

Ranina and *Lophoranina* have very broad sterna whereas *Bicornisranina* has a narrow sternum (Fig. 4). *Cyrtorhina* has a much smaller fused 1-3 sternal element, whereas *Bicornisranina* has a twice as wide fused 1-3 sternal element (Fig. 4). *Lyreidus*, *Raninella*, *Lysirude*, and *Rogueus* have lateral extensions on either side of sternal element 5 (Fig. 4), whereas in *Bicornisranina* sternal element 5 has very reduced lateral projections. *Notopus*, *Cosmonotus*, and *Ranilia* also have lateral extensions on either side of sternal element 5 not as well developed as in *Bicornisranina*, and *Ranidina* has a much narrower fused 1-3 sternal element. *Notopocorystes*, *Cretacoranina*, and *Eucorystes* all have a distinct sternal element 4 with rectangular lateral margins in outline, whereas *Bicornisranina* has a sternal element 4 with weakly concave lateral margins, with small triangular projections directed laterally. *Raninoides*, *Notosceles*, and *Quasileviranina* also have a more narrow fused 1-3 sternal element then seen in *Bicornisranina*. In addition, *Bicornisranina* lacks the medial groove as seen in *Raninoides* and *Quasileviranina*. The sternum of *Bicornisranina* is distinct from any other known sternum of Raninidae (Fig. 4). Therefore, a new genus is warranted to encompass the specimens described herein.

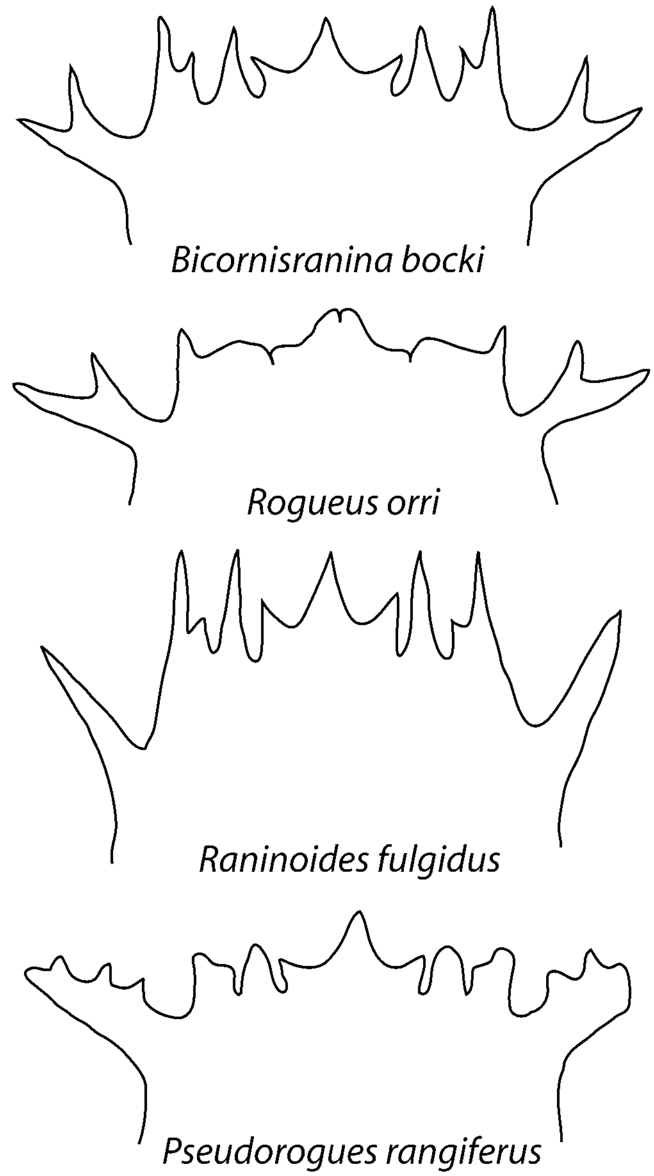

Fig. 3. Comparison line drawings of the frontal regions of the raninid crabs: *Bicornisranina bocki* this report; *Rogueus orri* Berglund and Feldmann, 1989, drawing adapted from Berglund and Feldmann (1989, fig. 2.1); *Raninoides fulgidus* Rathbun, 1926, drawing adapted from Schweitzer et al. (2000, fig. 3C); and *Psuedorogueus rangiferus* Fraaye, 1995, drawing adapted from Fraaye (1995, fig. 2).

Bicornisranina bocki n. sp.
Fig. 5A-5H

Diagnosis.—Carapace longer than wide, rectangular in outline, widest approximately one-third the distance posteriorly on carapace; fronto-orbital region broad, with well developed rostrum; rostrum bounded on either side by inner-orbital, intra-orbital and outer-orbital spines, fronto-orbital width about two-thirds maximum carapace width; anterolateral margin short, bounded by bifid anterolateral spine; posterolateral margin straight, tapers slightly posteriorly; posterior margin about half maximum carapace width; chelipeds equal in size, manus quadrate, flat. Sternal

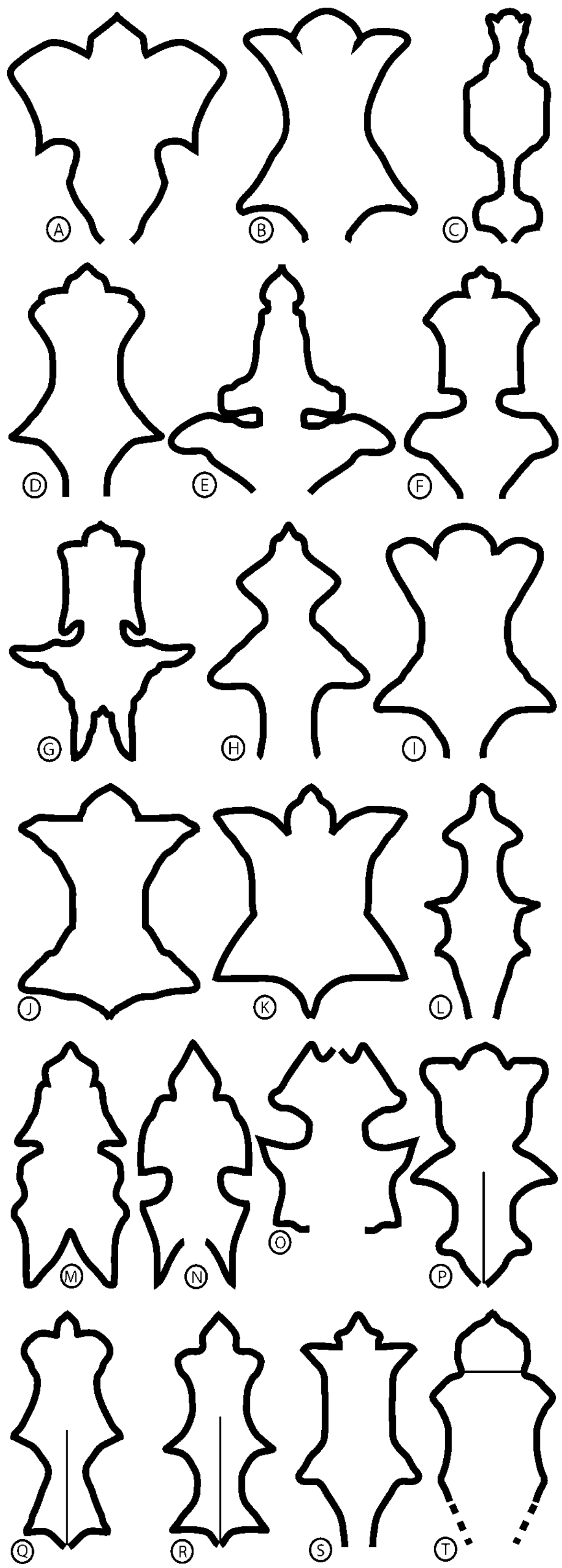

Fig. 4. Comparison line drawings of sterna from known and illustrated genera within the family Raninidae. Also refer to sterna line drawings by Guinot (1993) and Tucker (1995) and sterna descriptions by Davie (2002). Note drawings are not to scale and are drawn for comparison only. A, *Ranina ranina* (Linnaeus, 1758), drawn from USNM 2044 extant specimen. B, *Lophoranina reussi* (Woodward, 1866), adapted from Beschin et al. (1988, fig. 7.2). C, *Cyrtorhina oblonga* Beschin, Busulini, de Angeli and Tessier, 1988, adapted from Beschin et al. (1988, fig. 4). D, *Lyreidus tridentatus* De Haan, 1841, adapted from USNM 216686 as figured by Tucker (1995, fig. 22.2). E, *Raninella mucronata* adapted from Rathbun (1935, plate 14.33). F, *Lysirude channeri* (Wood-Mason, 1885) adapted from USNM 216686 as figured by Tucker (1995, fig. 28.2). G, *Rogueus orri* Berglund and Feldmann, 1989, adapted from Berglund and Feldmann (1989, fig. 3.2). H, *Notopus beryrichi* (Bittner, 1875), adapted from Beschin et al. (1988, fig. 10.2). I, *Notopus beyrichi* (Bittner, 1875) adapted from Beschin et al. (1988, fig. 10.2). J, *Cosmontus eocaenicus* Beschin, Busulini, de Angeli and Tessier, 1988, adapted from Beschin et al. (1988, fig. 2). K, *Ranilia muricata* H. Milne Edwards, 1937, adapted from USNM 207834 as figured by Tucker (1995, fig. 56.4). L, *Ranidina rosaliae* Bittner, 1893, adapted from Glaesner (1969, R501, fig. 3b). M, *Notopocorystes stokesii* (Mantel, 1844) adapted from Wright and Collins (1972, plate 14.2). N, *Notopocorystes stokesii* (Mantel, 1844) adapted from Wright and Collins (1972, plate 14.2). O, *Eucorystes eichhorni* Bishop, 1983 adapted from Bishop (1983, fig. 6-G). P, *Quasilaeviranina ovalis* (Rathbun, 1935) adapted from USNM 371689 as figured by Tucker (1995, fig. 106.2). Q, *Raninoides bouvieri* Capart, 1951, adapted from extant specimen USNM 121423. *Raninoides fulgidus* Rathbun, 1926 adapted from fossil specimen USNM 354151 as figured by Tucker (1995, fig. 75.5). S, *Notosceles ecuadorensis* (Rathbun, 1935) adapted from USNM 207834 as figured by Tucker (1995, fig. 101-2). T, *Bicornisranina bocki* reported herein (fig. 5D, E).

elements 1-3 fused; sternal element 4 lateral margins weakly concave; sternal element 5 rectangular in outline.

Description.—Carapace longitudinally rectangular in outline, strongly vaulted transversely, weakly vaulted longitudinally; carapace longer than wide, width about 65 percent maximum carapace length excluding anterolateral spine, including anterolateral spine length and width are about equal; widest approximately one-third the distance posteriorly on carapace; carapace regions poorly defined; carapace surface finely scabrous, especially along frontal region; carapace weakly ridged medially.

Frontal region broad; frontal width about 27 percent maximum carapace width excluding anterolateral spine and 18 percent including anterolateral spine. Rostrum triangular, about as long as broad, terminating in very sharp triangular spine; bounded on either side by weakly axially curved, triangular, acicular, inner-orbital spines. Orbits cylindrical, rounded; intra-orbital spine sharp, cylindrical, with rounded margins, terminates at same level as rostral spine; fronto-orbital width occupying about 79 percent maximum carapace width excluding anterolateral spine and about 52 percent including anterolateral spine. Outer-orbital spines posteriorly broad, rectangular; terminating anteriorly in two spines with shallow, concave fissure between; inner spine short, sharp and terminating slightly more distally than outer spine; outer spine sharp, rounded and terminating at same level as intra-orbital spine and rostrum; deep rounded, concave fissure between intra-orbital spine and outer-orbital spine.

Anterolateral margin short, bounded by large anterolateral spine; spine quadrate; becoming bifid approximately one-half the length distally from base; bifurcations equal in thickness, rounded, sharp; inner bifurcation weakly curving axially, directed forward; outer bifurcation directed anterolaterally, weakly curving forward; triangular concave

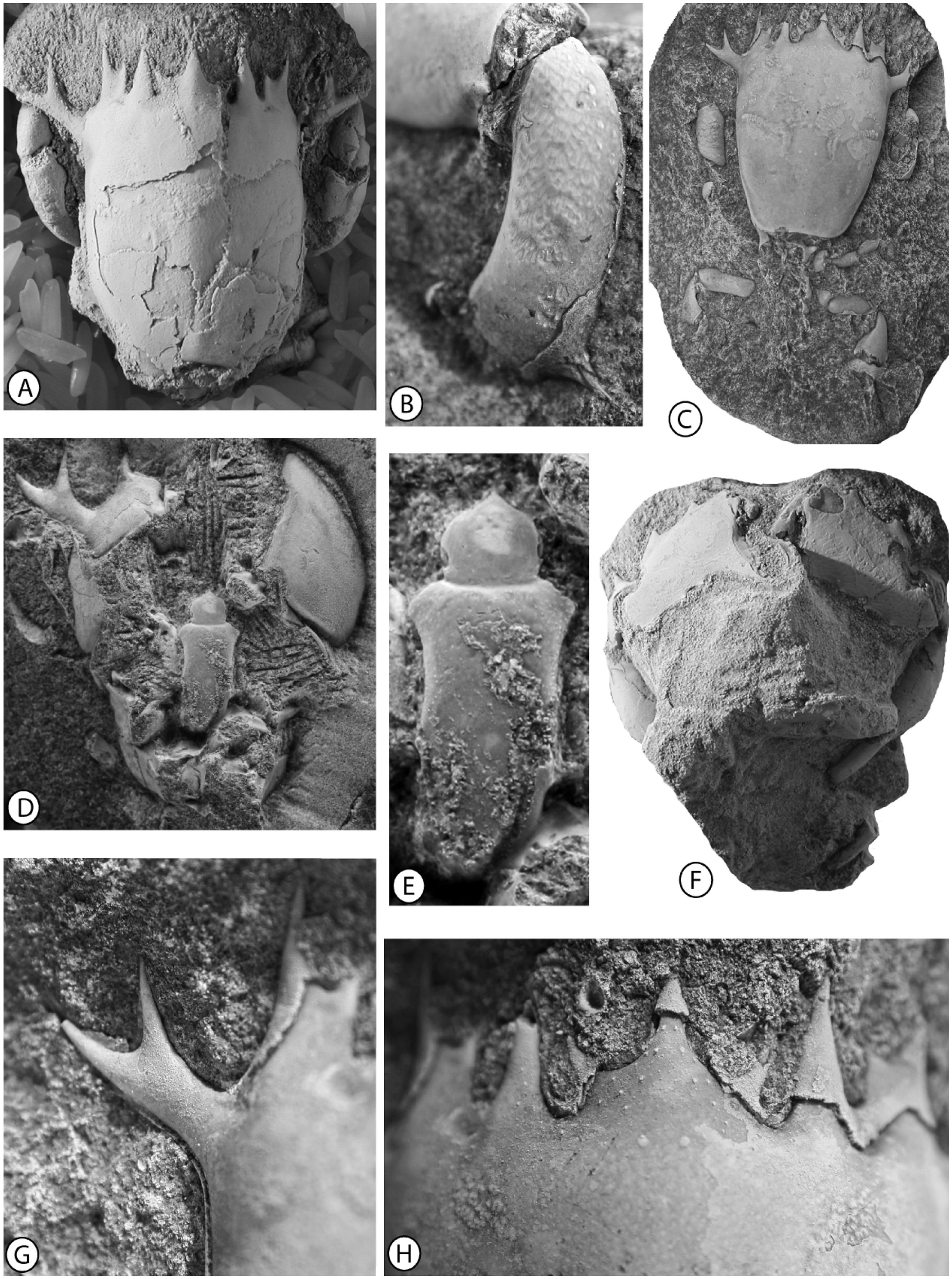

Fig. 5. *Bicornisranina bocki* n. gen., n. sp. A, dorsal view of carapace, holotype GSC 57082. 2X actual size; B, close-up view of spine on upper margin of carpus of chelae, VIPM 201. 8X actual size; C, dorsal view of carapace with partial appendages, VIPM 200. 1.5X actual size; D, ventral surface preserving portions of sternal elements, CDM 039. 2.5X actual size; E, Close up of sternal element, CDM 039. 6.5X actual size; F, view of chelipeds, GSC 57082. 2X actual size; G, close-up view of anterolateral spine, VIPM 200. 9X actual size; H, close-up view of frontal region, VIPM 200. 8X actual size.

Table 1. Measurements (in mm) taken on the dorsal carapace of *Bicornisranina bocki*. L1 = maximum carapace length; L2 = maximum length measured from tip of outer-orbital spine to base of fissure between outer-orbital spine and anterolateral spine; L3 = maximum posterolateral length measured from base of anterolateral spine to posterior margin; W1 = maximum carapace width including anterolateral spines; W2 = frontal width; W3 = fronto-orbital width; W4 = width between outer-orbital spine and anterolateral spine; W5 = width between bifid portion of anterolateral spine; W6 = maximum carapace width excluding anterolateral spines; W7 = posterior width. Refer to Fig. 6 for position and orientation of measurements.

Specimen	W1	W2	W3	W4	W5	W6	W7	L1	L2	L3
VIPM 200	29.14	5.1	16.65	5.17	3.12	20.82	10.37	30.19	5.21	20.82
VIPM 201	39.54	6.92	19.78	4.20	5.20	25.99	—	37.47	6.21	23.06
GSC 57082, holotype	35.34	6.21	17.23	6.23	5.25	20.95	*9.53	33.66	6.56	22.52

* Estimated.

fissure between bifurcations. Posterolateral margin uniform, weakly convex, weakly tapering posteriorly, rimmed; occupying about 66 percent maximum carapace length. Posterior margin broad, weakly concave; posterior width occupying about 48 percent maximum carapace width excluding anterolateral spine and about 33 percent including anterolateral spine. Branchiocardiac grooves as shallow arcuate depressions approximately placed mid-length of carapace extending from lateral margins terminating on either side of carapace midline.

Chelipeds equal in size. Merus rounded, cylindrical in cross section. Carpus rounded, cylindrical in cross section; tapering distally; broadly concave at articulation with manus; distinct sharp spine on upper margin just distal to carpus-manus articulation. Manus quadrate, flat; two triangular spines on upper margin directed distally; three small, equally spaced, triangular spines on lower margin, distal-most spine smallest. Fixed finger triangularly equilateral, terminating in downward-directed curving forward tooth; occlusal surface with five grooved, rectangular teeth; distinct groove just distal to teeth extending distance of occlusal surface. Dactylus not well known; appearing much thinner, more rounded than fixed finger, terminating in forward-curving, sharp tooth.

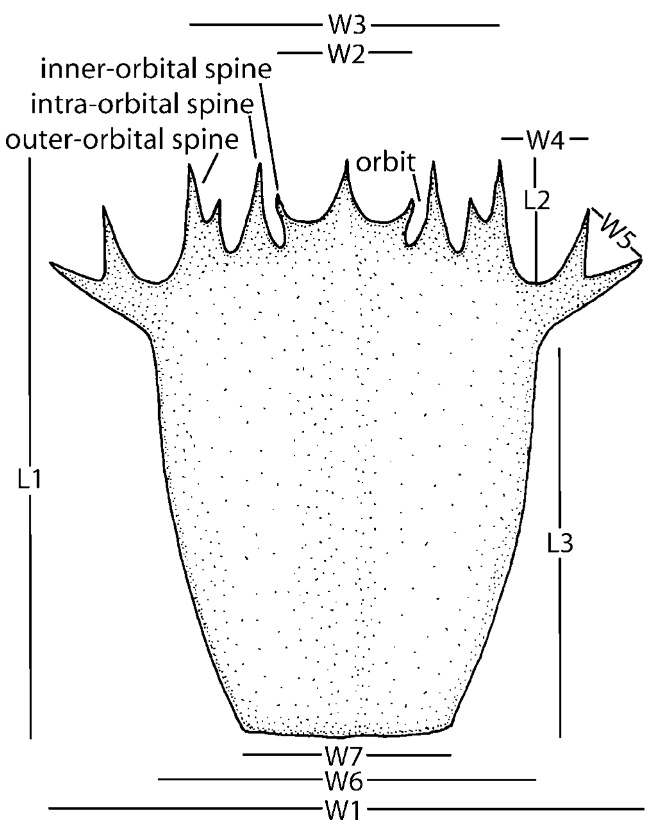

Fig. 6. Line drawing of the dorsal carapace of *Bicornisranina bocki*, illustrating position and orientation of measurements. Refer to table 1 for explanation of measurement positions.

First walking legs partially preserved. Carpus rectangular, slightly rounded. Propodus quadrate, flat. Dactylus flat, isosceles triangle in outline, terminates in sharp spine. Fourth walking legs partially preserved. Carpus cyclindrical, slightly rounded. Propodus quadrate, broad posteriorly tapering to weakly triangular termination anteriorly. Proximal portion of dactylus broad, flat, remainder unknown.

Sternum partially preserved. Sternal elements 1 through 3 fused, lateral margins rounded, anteriorly terminates to triangular spine, distinct shallow groove separates region from sternal element 4. Lateral margins of sternal element 4 very weakly concave, anteriorly with small triangular projections directed laterally. Sternal element 5 rectangular in outline. Pterygostomial region heavily inflated, roughly cylindrical in outline.

Etymology.—The trivial name honors Peter Bock of Nanaimo, British Columbia, who found and donated the first specimens of *Bicornisranina bocki*. His passion for paleontology has resulted in many important discoveries from Vancouver Island.

Type Material.—The holotype, GSC 57082, is deposited within the National Type Collection, Geological Survey of Canada Eastern Paleontology Division, Ottawa, Ontario, Canada. Two paratypes, VIPM 200 and 201, are deposited at the Vancouver Island Paleontological Museum, Qualicum Beach, Vancouver Island, British Columbia, Canada, and the third paratype, CDM 039, is deposited at the Courtenay and District Museum Palaeontology Centre, Vancouver Island, British Columbia, Canada.

Measurements.—Measurements made on the dorsal carapace of *Bicornisranina bocki* are given in Table 1; position and orientation of measurements are shown in Fig. 6.

Occurrence.—Three specimens VIPM 200, 201 and GSC 57082 were collected by Peter Bock and Bill Hessin from shoreline exposures of the Haslam Formation at Northwest Bay, at lat. 49°18′13.8″N, long. 124°12′86.7″W. The fourth specimen, CDM 039, was also collected from shoreline exposures of the Haslam Formation at Northwest Bay.

Several additional specimens collected from the late Santonian Pender Formation by Rick Ross from the Duncan Bay logging main overpass at kilometer 147 on New Inland Island Highway, near Courtenay, BC, at 49°51′05.9″N, 125°13′46.5″W, were also examined.

Discussion

The new species is based upon four well-preserved specimens preserving the dorsal carapace morphology and one specimen preserving the ventral surface. The holotype, GSC 57082, consists of a well-preserved dorsal carapace, preserving both chelae (Fig. 5). The paratypes VIPM 200 and VIPM 201 (Fig. 5) preserve the dorsal carapace and portions of the walking legs. The paratype CDM 039 preserves a portion of the sternum (Fig. 5).

Bicornisranina bocki was originally informally assigned to the genus *Rogueus* based upon the superficial resemblance of the anterolateral spines to that genus (Ludvigsen and Beard 1994) (Fig. 3). However, the differences in the conformation of the orbital spines and sternal elements between *Bicornisranina* and *Rogueus* are distinctly different (Figs. 3, 4). *Bicornisranina* from its description clearly belongs within Raninidae and additionally it can be placed within Raninoidinae with confidence. Although *Bicornisranina* shares morphological similarities to other genera within Raninidae, the sternum of *Bicornisranina* is clearly different from any known raninid sterna (Fig. 4).

Placement of *Bicornisranina* within Raninoidinae extends the geographical distribution of the subfamily into eastern North Pacific above the occurrences of *Raninoides* collected from Washington and Oregon (refer to Schweitzer et al., 2006 for a locality list of *Raninoides* spp.). *Bicornisranina* is a very early member of Raninoidinae and perhaps the earliest representative, but the genus *Cristofrons* collected from the lower Campanian to lower Maastrichtian (Feldmann et al., 1993) appears to be time contemporaneous with *Bicornisranina*. Placement of *Cristofrons* within Raninoidinae is questionable. Feldman et al. (1993) placed *Cristafrons* at the family level, but Tucker (1995) questionably placed the genus within Raninoidinae. With the occurrence of *Bicornisranina* from lower Campanian rocks of Vancouver Island, Canada, Raninoidinae is confidently extended into the Cretaceous. *Bicornisranina* represents one of the earliest occurrences within Raninoidinae. The other genera within the subfamily include: *Raninoides*, is known from the Paleocene to Recent; *Cristafrons*, from the Upper Cretaceous; *Notopoides*, from the Eocene to Recent; and *Quasilaeviranina*, from the Paleocene to Eocene.

Acknowledgements

Peter Bock, Bill Hessin, and Rick Ross of Vancouver Island, British Columbia collected, prepared, and generously donated the fossil material used in this study. Graham Beard of Qualicum Beach, British Columbia, allowed access to the VIPM collection and accessioned the fossils used in this study. Graham Beard has also provided assistance to the authors in photographing the specimens. Steve Hetrick prepped and generously donated the specimen that shows the sternum, an invaluable contribution to this manuscript. Peter Mustard, Department of Earth Sciences, Simon Fraser University, allowed the use of his outcrop and geology maps. Peter Mustard and Jim Haggart, Geological Survey of Canada, provided valuable discussion and insight into the geological setting of various Nanaimo group localities. Both authors are greatly indebted to these individuals and numerous others in the preparation of this manuscript.

References

Bell, T. 1863. A monograph of the fossil malacostracous Crustacea of Great Britian. Part II, Crustacea of the Gault and Greensand. Paleontological Society of London, 40 p.

Berglund, R. E., and R. M. Feldmann. 1989. A new crab, *Rogueus orri* n. gen. and sp. (Decapoda: Brachyura), from the Lookingglass Formation (Ulatisian Stage: lower middle Eocene) of southwestern Oregon. Journal of Paleontology 23: 69-73.

Beschin, C., A. Busulini, A. De Angeli, and G. Tessier. 1988. Raninidae del Terziario berico-lessineo (Italia settentrionale). Lavori. Societa Veneziana de Scienze Naturali 13: 155-215.

Bishop, G. A. 1983. Two new species of crabs, *Notopocorystes* (*Eucorystes*) *eichhorni* and *Zygastrocarcinus griesi* (Decapoda: Brachyura) from the Bearpaw Shale (Campanian) of north-central Montana. Journal of Paleontology 57: 900-910.

Bittner, A. 1875. Die Brachyuren des Vicentinischen Tertiŏrgebirges. Denkschriften der Kaiserlichen Akademie der Wissenschaften in Wien, Mathematisch-Naturwissenchaftliche Klasse 34: 63-106.

———. 1893. Decapoden des pannonischen Tertiärs. Sitzungberichte der Kaiserlich Akademie der Wissenschaften in Wien, Mathematisch-Naturwissenchaftliche Klasse 102: 10-37.

Bourne, G. C. 1922. On the Raninidae: a study in carcinology. Journal of the Linnaean Society of London, Zoology 35: 25-29.

Capart, A. 1951. Crustacés Décapodes Brachyoures. Expédition Océanographique Belge dans les eaux côtières Africaines de l'Atlantique Sud (1948-1949). Résultats Scientifiques, III (1): 11-205.

Davie, P. J. F. 2002. Crustacea: Malacostrata; Eucarida (Part 2): Decapoda - Anomura, Brachyura. In, A. Wells and W. W. K. Houston (eds.), Zoological Catalogue of Australia Vol. 19.3B. CSIRO Publishing, Melbourne, Australia, xiv, 641 p.

De Haan, W. 1833-1850. Crustaceana: I-xviii, 1-xxxi, ix-xvi, 1-243, pls. A-J, L-Q, 1-55, circ. Table 2. In, Fauna Japonica sive descriptio animalium, quae in itinereper Japoniam, jussu et auspiciis superiorum, qui summum in India Batava Imperium tenent, suspecto, annis 1823-1830 collegit, notis, observationibus et adumbrationibus illustravit. Edited by P. F. von Siebold, Amsterdam.

Enkin, R. J., J. Baker, and P. S. Mustard. 2001. Paleomagnetism of the Upper Cretaceous Nanaimo Group, southwestern Canadian Cordillera. Canadian Journal of Earth Sciences 38: 1403-1422.

Fabiani, R. 1910. I crostacei terziarii del Vicentino. Bolletino del Museo Civico Vicenza, I(1): 40 p.

Feldmann, R. M., and C. B. McPherson. 1980. Fossil decapod crustaceans of Canada. Geological Survey of Canada Paper 79-16, 20 p.

———, D. M. Tshudy, and M. R. A. Thompson. 1993. Late Cretaceous and Paleocene decapod crustaceans from James Ross Basin, Antarctic Peninsula. Paleontological Society memoir 28, 41 p.

Fraaye, R. H. B. 1995. A new raninid crab, *Pseudorogueus rangiferus* (Decapoda: Crustacea), from the Eocene of Spain. Estudios Geologicos 51: 65-67.

Glaessner, M. F. 1969. Decapoda, p. R400-R566. In, R. C. Moore (ed.), Treatise on Invertebrate Paleontology, Part R, Arthropoda 4. Geological Society of America and University of Kansas Press, Lawrence.

Goeke, G. D. 1985. Decapod Crustacea: Raninidae. Mémoire Muséum National l'Histoire Naturelle, Series A, Zoologie 133: 205-228.

Guinot, D. 1993. Données nouvelles sur les Raninoidea De Haan, 1841 (Crustacea Decapoda Brachyura Podotremata). Compte Rendu Académie des Sciences de la vie 316: 1324-1331.

Haggart, J. W. 1991. A new assessment of the age of the basal Nanaimo Group, Gulf Islands, British Columbia. Current Research, Part E; Geological Survey of Canada Paper 91- 1E: 77-82.

———. 1994. New results in Jura-Cretaceous stratigraphy, northern Vancouver Island, British Columbia. Current Research - Geological Survey of Canada Vol. 1994-E: 59-66.

Haq, B. U., J. Hardenbol, and P. R. Vail. 1988. Mesozoic and Cenozoic chronostratigraphy and ustatic cycles. In, Sea-level Research: an Integrated Approach. Society of Economic Paleontologists and Mineraologists Special Publication 42: 71-108.

Jeletzky, J. A. 1973. Age and depositional environment of Tertiary rocks of Nootka Island, British Columbia (92E): mollusks versus foraminifers. Canadian Journal of Earth Science 10: 331-365.

Lamarck, J. B. P. A. de. 1801. Systême des animaux sans vertebras, ou tableau général des classes, des orders et des genres de ces animaux; présentant leurs caractères essentials et leur distribution, d'après la consideration de leurs rapports naturels et de leur organization, et suivant l'arrangement établi dnas les galleries du Muséum d'Histoire Naturelle, parmi leurs dépouilles conserves; precede du discours d'ouverture du cours de zoologie, donné dans le Muséum national d'Histoire naturelle l'an 8 de la République, 432 p.

Latreille, P. A. 1802-1803. Histoire naturelle, générale et particuliè re, des crustacés et des insectes, Volume Dufart, Paris, 201 p.

Linnaeus, C. von. 1758. Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis: edit. 10, vol. 1, Laurentii Salvii (Homiae).

Lőrenthey, E., and K. Beurlen. 1929. Die fossilen decapoden der Länder der Ungarischen Krone. In, Geologica Hungarica, Series Palaeontologica, Budapest, pt. 3: 1-420.

Ludvigsen, R., and G. Beard. 1994. West Coast Fossils. Whitecap Books, Vancouver/Toronto 216 p.

M'Coy, F. 1849. On the classification of some British fossil Crustacea, with notices of new forms in the university collections at Cambridge. The Annals and Magazine of Natural History 4: 161-179.

Mantell, G. A. 1844. Medals of Creation, 2, pp. I-viii, 457-1016, London.

Mertin, H. 1941. Decapode Krebse aus dem subhercyenen und Braunschweiger Emscher und Untersenon sowie Bemerungen ueber einige verwandte Formen in der Oberkriede. Nova Acta Leopoldina 10: 149-262.

Milne Edwards, A. 1862. Sur l'existence de Crustacés de la famille des Raniniens pendant la période crétacée. Comptes Rendus de l'Academie des Sciences de Paris 55: 492-494.

Milne Edwards, H. 1837. Histoire naturelle des Crustacés com renant l'anatomie, la physiologie et la classification des animaux 2: 1-532, Paris.

McGugan, A. 1979. Biostratigraphy and paleoecology of Upper Cretaceous (Campanian and Maestrichtian) foraminifera from the upper Lambert, Northumberland, and Spray formations. Canadian Journal of Earth Sciences 16: 2263-2274.

Monod, T. 1956. Hippidea et Brachyura ouest Africans. Mémoires de l'Institut Français d' Afrique Noire 45: 1-674.

Muller, J. E., and J. A. Jeletzky. 1970. Geology of the upper Cretaceous Nanaimo Group, Vancouver Island, and Gulf Islands, British Columbia. Geological Survey of Canada Paper 69-25, 77 p.

Mustard, P. S. 1994. The Upper Cretaceous Nanaimo Group, Georgia Basin. In, J. W. H. Monger (ed.), Geology and Geological Hazards of the Vancouver Region, southwestern British Columbia. Geological Survey of Canada Bulletin 481, p. 27-95.

Rathbun, M. J. 1926. The fossil stalk-eyed Crustacea of the Pacific Slope of North America. United States National Museum Bulletin 138, 155 p.

———. 1935. Fossil Crustacea of the Atlantic and gulf coastal plain. Geological Society of America Special Papers number 2, 160 p.

Schweitzer, C. E., R. M. Feldmann, G. González-Barba, and V. Ćosović. 2006. New Decapoda (Anomura, Brachyura) from the Eocene Bateque and Tepetate Formations, Baja California Sur, México. Bulletin of the Mizunami Fossil Museum 33: 21-45.

———, R. M. Feldmann, A. B. Tucker, and R. E. Berglund. 2000. Eocene decapod crustaceans from Pulali Point, Washington. Annals of Carnegie Museum 69: 23-67.

———, R. M. Feldmann, J. Fam, W. A. Hessin, S. W. Hetrick, T. G. Nyborg, and R. L. M. Ross. 2003. Cretaceous and Eocene decapod crustaceans from southern Vancouver Island, British Columbia, Canada. NRC Research Press, Ottawa, Canada, 66 p.

Serène, R., and A. F. Umali. 1972. The family Raninidae and other new and rare species of brachyuran decapods from the Philippines and adjacent regions. The Philippine Journal of Science 99: 21-105.

Sliter, W. V. 1973. Upper Cretaceous foraminiferas from the Vancouver Island area, British Columbia, Canada. Journal of Foraminiferal Research 3: 167-186.

Tucker, A. B. 1995. A systematic evaluation of fossil Raninidae from the Twin River Group, Olympic Peninsula, Washington, and a re-examination of the Raninidae. Unpublished Ph.D. dissertation, Kent State University, Kent, Ohio, 363 p.

———. 1998. Systematics of the Raninidae (Crustacea: Decapoda: Brachyura), with accounts of three new genera and two new species. Proceedings of the Biological Society of Washington 111: 320-371.

Ward, P. D. 1978. Revisions to the stratigraphy and biochronology of the Upper Cretaceous Nanaimo Group, British Columbia and Washington State. Canadian Journal of Earth Sciences 15: 405-423.

White, A. 1847. Descriptions of new Crustacea from the Eastern Sea. Proceedings of the Zoological Society of London, 15: 56-58.

Whiteaves, J. F. 1884 [1885]. Note on a decapod crustacean from the Upper Cretaceous of Highwood River, Alberta, Northwest Territories. Royal Society of Canada Transactions for 1884 2: 237-238.

———. 1885. Part I. Report on the Invertebrates of the Laramie and Cretaceous rocks of the vicinity of the Bow and Belly Rivers and adjacent localities in the Northwest Territories. Geological Survey of Canada Contributions to Paleontology 1: 1-89.

———. 1895. On some fossils from the Nanaimo Group of the Vancouver Cretaceous. Transactions of the Royal Society of Canada from 1895 1: 119-133.

———. 1903. Mesozoic fossils, 1, Part V. On some additional fossils from the Vancouver Cretaceous with a revised list of the species there from. Geological Survey of Canada, pp. 309-409.

Wood-Mason, J. 1885. [Exhibition of] "*Lyreidus channeri*, a remarkable new blind brachyurous crustacean from the depth of the Bay of Bengal". Proceeinds of the Asiatic Society of Bengal, p. 104.

Woodward, H. 1866. Note on a new *Ranina* (*Ranina porifera* from the Tertiary strata of Trinidad. Quarterly Journal of the Geological Society of London 22: 591-592.

———. 1896. On some podophthalmous Crustacea from the Cretaceous Formation of Vancouver and Queen Charlotte Islands. Quarterly Journal of the Geological Society of London 52: 221-228.

———. 1900. Further note on podophthalmous crustaceans from the Upper Cretaceous Formation of British Columbia, etc. Geological Magazine 7: 392-401 (part 1), 433-435 (part 2).

Wright, C. W., and J. S. H. Collins. 1972. British Cretaceous crabs. The Palaeontological Society Monographs, London, 114 p.

RECEIVED: 26 December 2007.
ACCEPTED: 30 January 2008.