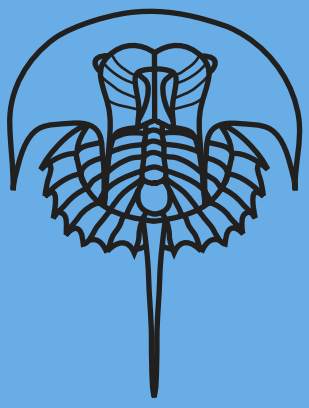


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Part R, Revised, Volume 1, Chapter 8S: Systematic Descriptions: Section Raninoida

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PART R, REVISED, VOLUME 1, CHAPTER 8S: SYSTEMATIC DESCRIPTIONS: SECTION RANINOIDA

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Section RANINOIDA Ahyong & others, 2007

[*nom. transl.* Ahyong & others, 2007, p. 584, *pro* Raninoidea de Haan, 1839 in 1833–1850, p. 102]

Elongate or equidimensional brachyurans, rarely wider than long, usually vaulted transversely; regions usually poorly defined; cervical groove ending at pleural suture. Inner-orbital and outer-orbital grooves well developed; intraorbital (or inner-orbital) and supraorbital lobes or spines present; anterolateral spines usually present. Mouthparts taper anteriorly (oxystomatous condition). No sterno-pleonal cavity; elongate pleural somite 6. Pleon narrow in males and females, with reduced but clear dimorphism. Genital openings coxal, spermatheca present. [Emended from Karasawa & others, 2014, p. 229.] *Lower Cretaceous (Berriasian–Hauterivian)–Holocene.*

Superfamily NECROCARCINOIDEA Förster, 1968

[*nom. transl.* Karasawa & others, 2014, p. 229, *pro* Necrocarcininae Förster, 1968, p. 169]

Carapace about as wide as long or slightly wider; fronto-orbital margin usually narrow (except Orithopsidae), orbits horizontal, with two fissures, horizontally directed; inner-orbital lobe or spine positioned at the base of the rostrum; epibranchial ridge, usually with well-developed epibranchial spine present but sometimes weak; mesobranchial and metabranchial ridges present, tubercular or granular (except Camarocarcinidae); anterolateral and posterolateral margins well differentiated; anterolateral and usually posterolateral margins with spines; sternum narrow, flattened axially, sternites 1–3 fused, sternite 4 longer than wide, sternal sutures 3/4 incomplete and 4/5 well developed; pleonal locking mechanism composed of double pegs where known; pleonal somites free, may have axial spines; pereiopod 5 and sometimes 4, when known, reduced in size; gymnopleuran condition absent. [Emended from Schweitzer, Karasawa, & others, 2016, p. 345.] *Lower Cretaceous (Berriasian–Hauterivian)–Oligocene (Rupelian).*

Araripecarcinus Martins-Neto, 1987, p. 406 [**A. ferreirai;* OD]. Carapace subcircular, about as wide as long, widest at midlength; pterygostome broad, vaulted, and granular; anterolateral and posterolateral margins convex, appearing to be entire; cervical groove reaching ventral carapace; buccal cavity elongate, about half carapace length. Sternum narrow, sternites 3 and 4 distinct, longer than wide; episternites 4 and 5 elongate, directed posterolaterally; wide; sutures 4/5 and 5/6 incomplete; pleonal locking mechanism absent; sterno-coxal depression absent; chelipeds isochelous; pereiopods 2 and 3 longest of pereiopods; pereiopod 4 about half the length of pereiopods 2 and 3; pereiopod 5 reduced, possibly subdorsal. [Emended from Luque, 2015, p. 154.] *Lower Cretaceous (Albian):* Brazil.——Fig. 1. **A. ferreirai*, holotype, USP GP/1T 1477, ventral view, scale bar, 1 cm (new; photo by P. Sucerquia, Universidade de São Paulo, Brazil).

Family CAMAROCARCINIDAE Feldmann, Li, & Schweitzer, 2007

[Camarocarcinidae Feldmann, Li, & Schweitzer, 2007, p. 1742]

Carapace nearly circular in outline, length about 96 percent maximum width, strongly vaulted transversely and longitudinally. Front

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Fig. 1. Family Uncertain (p. 1).

narrow, sulcate, downturned, with axial projection and two, smaller lateral spines. Fronto-orbital margin narrow; fronto-orbital width ranging from 25 to 46 percent maximum carapace width; orbits directed forward, deepest axially; upper margin of orbits quadrate to circular, rim flared upward, with two orbital fissures; orbits elevated on carapace well above anterolateral margin; inner-orbital lobes anteriorly located. Anterolateral and posterolateral margins with spines. Branchiocardiac groove defined by row of obliquely directed, elongate pits; cervical groove less strongly developed to obscure; mesobranchial and metabranchial ridges absent. Cuticle with endocuticular pillars extending up to or through exocuticle surface; cuticle surface nearly smooth to granular. Third maxillipeds much longer than wide, oriented in two planes, one nearly perpendicular to dorsal surface of carapace, the other parallel to ventral surface of carapace; sternum very narrow, sternal elements flattened axially and nearly vertical laterally. [Emended from Schweitzer, Karasawa, & others, 2016, p. 345.] *Upper Cretaceous (Campanian)–Paleocene.*

Camarocarcinus Holland & Cvancara, 1958, p. 499, pl. 74,*1–14* [**C. arnesoni*; OD]. Carapace about as wide as long, narrowing posteriorly, widest at about midlength; rostrum narrow, deflexed, sulcate; orbits directed forward, with two fissures; anterolateral and posterolateral margins confluent, armed with four discrete, long, forward-curved spines; remainder of margins smooth; regions very poorly developed; cervical and branchiocardiac grooves well defined; chelipeds isochelous. [Karasawa & others, 2014, p. 231.] *Paleocene:* Denmark, Greenland, USA (North Dakota).——Fig. 2,*1a. *C. arnesoni,* holotype, USNM 562093, dorsal view, Paleocene, North Dakota, scale bar, 1 cm (Karasawa & others, 2014, fig. 4A–B).——Fig. 2,*1b. C. quinquetuberculatus* Collins & Rasmussen, 1992, cast of holotype numbered KSU D 762, ventral view,

Paleocene, Greenland, scale bar, 1 cm (Karasawa & others, 2014, fig. 4).

Cretacocarcinus Feldmann, Li, & Schweitzer, 2007, p. 1747, fig. 4,1, 6–7 [**C. smithi;* OD]. Carapace nearly circular in outline, length about 96 percent maximum width, carapace widest about 40 percent the distance posteriorly, strongly vaulted transversely and longitudinally. Front narrow, sulcate, and downturned, with axial projection and two, smaller lateral spines. Orbits directed forward and upward, orbits deepest axially; upper margin of orbits quadrate to circular, rim flared upward, with two orbital fissures; orbits elevated on carapace well above anterolateral margin; fronto-orbital width largest in family, about 46 percent maximum carapace width. Spines present on both anterolateral and posterolateral margins. Branchiocardiac groove defined by row of obliquely directed, elongate pits; cervical groove well developed, nearly as strong as branchiocardiac groove. Carapace ornamented with nodes and spines, not arrayed in rows. Cuticle with endocuticular pillars extending up to or through exocuticle surface; cuticle surface nearly smooth to granular. Pterygostomial region with stridulating ridge. Third maxillipeds much longer than wide, oriented in two planes, one nearly perpendicular to dorsal surface of carapace, other parallel to ventral surface of carapace; sternum very narrow, sternal elements flattened axially, nearly vertical laterally. [Emended from Feldmann, Li, & Schweitzer, 2007, p. 1747.] *Upper Cretaceous (Campanian):* Manitoba, Canada.——Fig. 2,*2*. **C. smithi,* holotype, I-4077, dorsal view, scale bar, 1 cm (Feldmann, Li, & Schweitzer, 2007, fig. 6,*1*).

Family CENOMANOCARCINIDAE Guinot, Vega, & Van Bakel, 2008

[Cenomanocarcinidae Guinot, Vega, & Van Bakel, 2008, p. 684]

Carapace hexagonal to rounded, usually wider than long; orbits closely spaced, with two fissures; rostrum projected weakly beyond orbits, with five spines; anterolateral margins spinose, with at least 5 spines; posterolateral margins with one or two spines; carapace moderately vaulted transversely and longitudinally; cervical groove reduced; branchiocardiac groove weak; carapace bearing transverse and longitudinal ridges ornamented with tubercles; longitudinal median ridge present; epibranchial ridge well developed; branchial ridge arcuate; protogastric region with transverse ridge; maxillipeds very long; male sternum ovate, broadly concave; sternites 1–3 fused, forming a triangular shape; sternite 4 trapezoidal, longer than wide, with projections extending from anterior end, pereiopod 1 articulating from concavity at about midlength; sternal suture 4/5 deep, concave posterolaterally, becoming straight and oriented parallel to axis of animal axially;

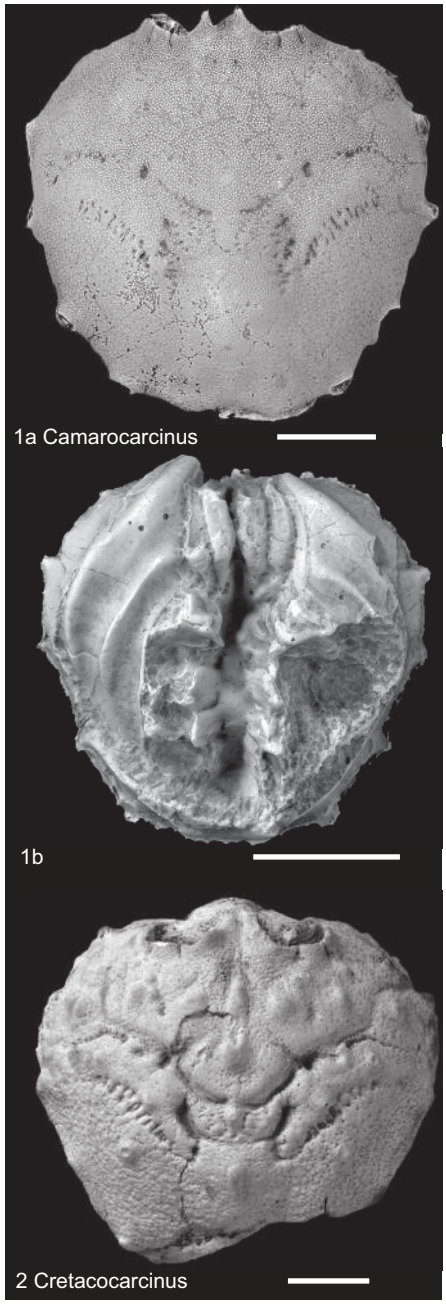


Fig. 2. Camarocarcinidae (p. 2–3).

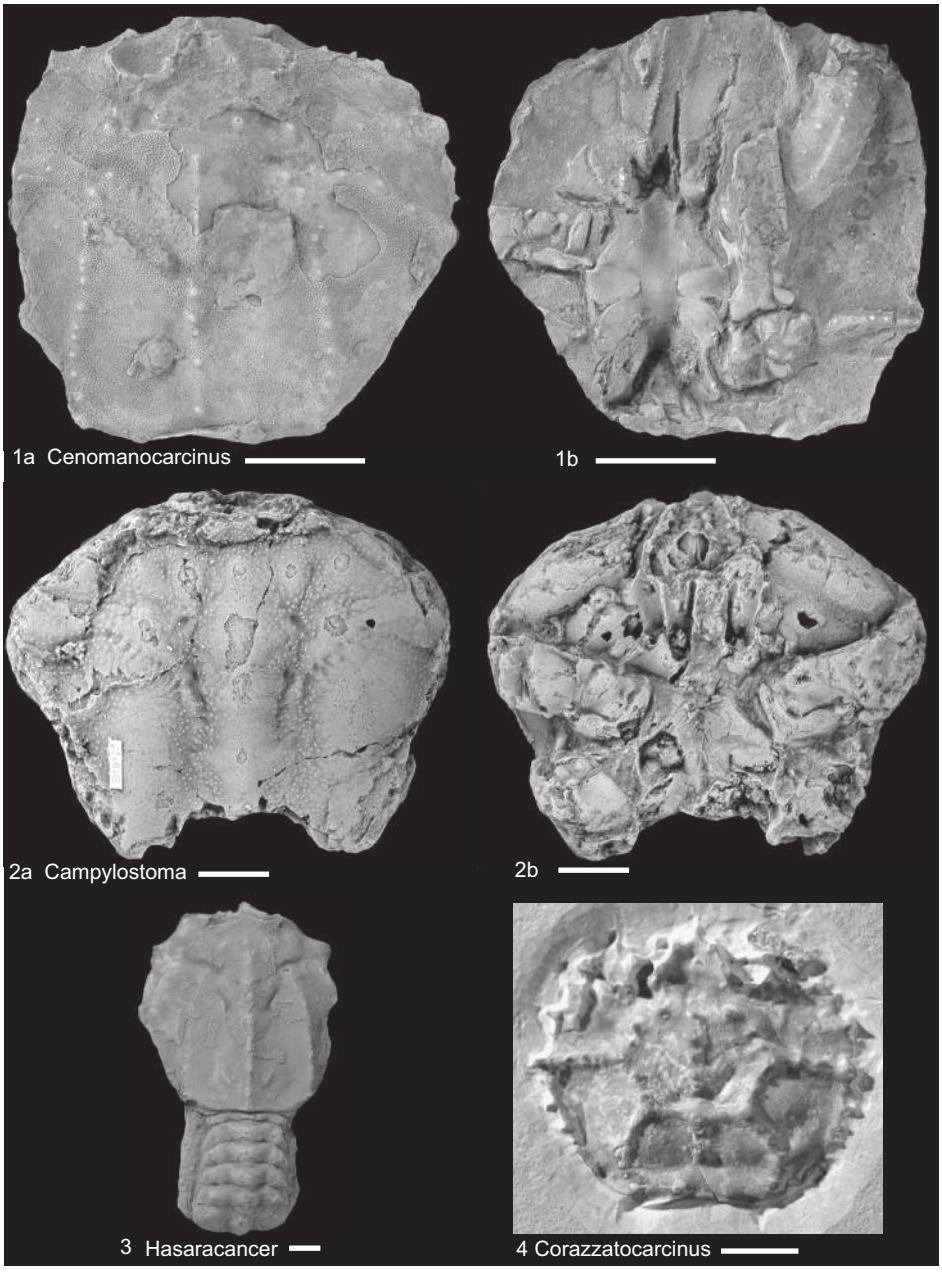


FIG. 3. Cenomanocarcinidae (p. 5).

sternite 5 wider than long, articulating with pereiopod 2, with two tubercles on each side probably serving to hold pleon in place and directed posterolaterally; sternite 6 inclined at moderate angle to remainder of sternum; sternites 7 and 8 unknown; sternal sutures 5/6 and 6/7 complete; pleon of male moderately wide, telson much longer than wide, somites 5 and 6 with three spines, one axial and one on each side; pereiopod

5 much reduced in size. [Emended from Schweitzer, Karasawa, & others, 2016, p. 346.] *Lower Cretaceous (Albian)–Eocene (Ypresian), ?Priabonian.*

Cenomanocarcinus Van Straelen, 1936, p. 37, pl. 4,*8* [**C. inflatus;* M; =*Neocrocarcinus inflatus* A. Milne-Edwards, 1886, p. 244, *nom. nud.*] [=*Sagittiformosus* Bishop, 1988, p. 379 (type, *S. carabus,* p. 379, fig. 1*K,N;* OD]. Carapace ovate or hexagonal, wider than long; two orbital fissures; rostrum sulcate, downturned, usually with trifid tip; tubercles of carapace arranged in ridges; three longitudinal ridges, one axial and one on each branchial region; two transverse gastric ridges. [Karasawa & others, 2014, p. 232.] *Lower Cretaceous (Albian)–Upper Cretaceous (Cenomanian):* Colombia, Spain, USA (Oklahoma, Texas), *Albian;* France, Israel, Lebanon, Nigeria, USA (Texas), *Cenomanian;* Colombia, Canada (British Columbia), France, Germany, Israel, Nigeria, USA (New Mexico, Texas, Wyoming), *Turonian;* Niger, *Coniacian–Maastrichtian;* Colombia, Canada (British Columbia), *Coniacian;* Colombia, Austria, *Santonian;* USA (New Jersey), *Campanian;* USA (North Dakota), *Maastrichtian.*——Fig. 3,*1a–b. C. vanstraeleni,* Stenzel, 1945, syntype, UT 21091, Cenomanian–Turonian, Texas, USA: *a*, dorsal view; *b*, ventral view, scale bars, 1 cm (Karasawa & others, 2014, fig. 5).

Campylostoma Bell, 1858, p. 23, pl. 23,*8–10* [**C. matutiforme;* M]. Carapace about as long as wide, ovate, weakly vaulted transversely and longitudinally, and front narrow, bifid, axially sulcate, with a large node at the base on either side; orbits elongate-oval, directed antero-dorsally, upper margin with blunt intraorbital spine and outer-orbital spine, lower orbital margin with suborbital spine, entire suborbital margin visible dorsally; fronto-orbital width about half maximum carapace width. Anterolateral margin with four spines excluding outer-orbital spine, with first two directed anterolaterally, third directed laterally, and last one largest, directed posterolaterally; posterolateral margin nearly straight; posterior margin narrow, rimmed, concave. [Emended from Karasawa & others, 2014, p. 232.] *Paleocene (Danian)–Eocene (Ypresian, ?Priabonian):* Sweden, *Danian;* Belgium, UK (England), *Ypresian;* western Russia.——Fig. 3,*2a–b*. **C. matutiforme,* SM C19127, Ypresian, England; *a*, dorsal view; *b*, ventral view, scale bars, 1 cm (Karasawa, Schweitzer, & Feldmann, 2011, fig. 9D–E).

Corazzatocarcinus Larghi, 2004, p. 530 [**Geryon hadjoulae* Roger, 1946, p. 43, pl. 8,*1;* OD]. Carapace ovate, about as wide as long; front projecting slightly beyond orbits, trifid; orbits rimmed, directed forward; anterolateral margins with several short, sharp spines; posterolateral margin with several small spines; axial regions with keel-bearing tubercles; protogastric region with central tubercles; epibranchial region with arcuate, tubercled keel connecting to transverse keel on cardiac region; oblique, arcuate keel extending from cardiac region to posterolateral corner; chelipeds short; pereiopods 2 and 3 long, slender; pereiopod 4 and 5 short, dactyl curved and short; female pleon with straight sides, telson triangular, somites with transverse swellings. [Emended from Karasawa & others, 2014, p. 233.] *Upper Cretaceous (Cenomanian):* Lebanon.——Fig. 3,*4*. **C. hadjoulae* (Roger), MSNM i26053, dorsal view, scale bar, 1 cm (new).

Hasaracancer Jux, 1971, p. 157, pl. 17 [**H. cristatus;* OD]. Carapace as wide as long or slightly longer than wide; cervical groove deep; axial keel with tubercles; two lateral keels; posterolateral margin straight to slightly convex; posterior margin convex; pleonal somites with three large tubercles each; pleurae long, with sharp terminations directed posteriorly. [Karasawa & others, 2014, p. 233.] *Upper Cretaceous (Campanian):* Afghanistan, Morocco.——Fig. 3,*3*. **H. cristatus,* cast of holotype, BSP 1988 III (numbered, KSU D 560), Campanian, Afghanistan, dorsal carapace and pleon, scale bar, 1 cm (Schweitzer, Karasawa, & others, 2016, fig. 3E).

Family NECROCARCINIDAE Förster, 1968

[*nom. transl.* Schweitzer & Feldmann, 2000, p. 241, *pro* Necrocarcininae Förster, 1968, p. 169]

Carapace circular or ovate, about as long as wide or slightly wider than long, widest at position of last anterolateral spine (epibranchial spine), about 40 to 50 percent of the distance posteriorly, moderately to strongly vaulted longitudinally and transversely; dorsal carapace regions well defined, usually ornamented with large tubercles or spines on most regions; tubercle on epibranchial region between cervical groove and secondary groove; rostrum narrow, sulcate at tip or with small spines; orbits small, circular, with two fissures, orbital margin directed forward and slightly upward; inner-orbital, intraorbital, and outer-orbital spines well developed; fronto-orbital width typically between 45 and 55 percent maximum carapace width; orbits usually set above anterolateral margins, infraorbital lobe present in some genera (*sensu* Van Bakel & others, 2012); anterolateral margins long, usually with at least five spines; posterolateral margin with spines or rarely entire; cervical and branchiocardiac grooves well developed, arcuate, usually parallel to one another; postcervical groove crossing midline; secondary groove

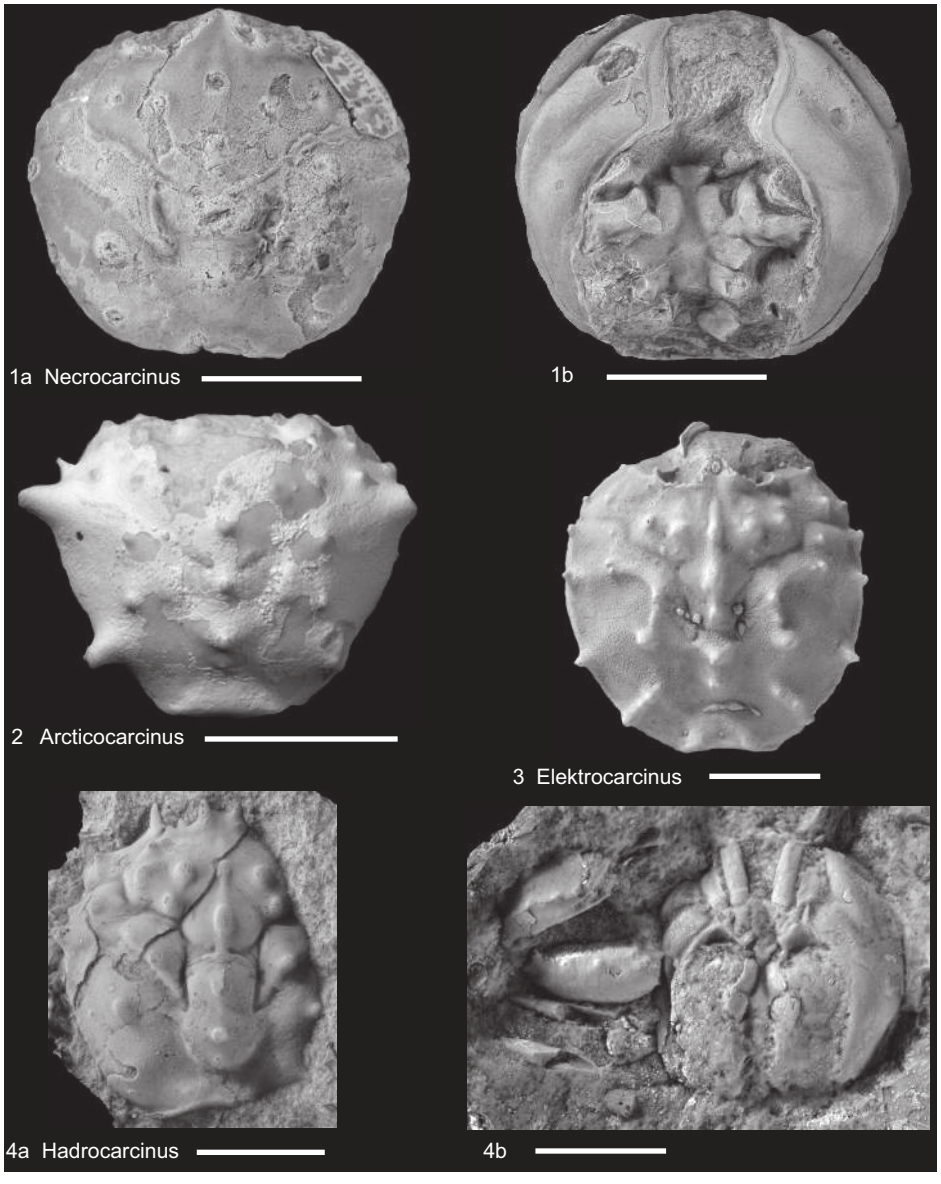


FIG. 4. Necrocarcinidae (p. 7–8).

anterior to cervical groove arising at about half distance along anterolateral margin, extending straight onto carapace, then making a nearly 90° turn posteriorly to meet cervical groove, secondary groove as deep as or deeper than cervical groove; epibranchial region developed into digitate extension directed at metagastric or urogastric region; axial regions distinctly inflated, developed into mesogastric, metagastric, cardiac, intestinal regions, urogastric conspicuously short or absent. Protogastric and hepatic regions equally inflated. Epibranchial region ornamented with tubercles. Sternum narrow, sternites 1–3 fused and quadrate; anterior portion of sternum at low angles to one

another; sternum deep posteriorly, with flanks at high angle to one another, lateral margins raised and granular; sternite 4 long, with widely raised lateral margins, axially deep, episternal projections short, sternal suture 4/5 incomplete, deep and concave posterolaterally, becoming straight and oriented parallel to axis of animal axially; sternite 5 wider than long, directed laterally; sternite 6 similar to sternite 5; sternite 7 directed ventrolaterally; sternite 8 directed ventrolaterally, much smaller than sternite 7; sternal sutures 5/6 and 6/7 complete. All pleonites free, with blunt axial spines, somite 6 much longer than wide, telson long; pereiopods 4 and 5 apparently reduced in size. [Emended from SCHWEITZER, KARASAWA, & others, 2016, p. 349.] *Lower Cretaceous (Aptian)–Paleocene (Danian).*

Necrocarcinus BELL, 1863, p. 19 [**Orythia labeschii* EUDES-DESLONGCHAMPS, 1835, p. 40, pl. 1,*7–8;* SD WITHERS, 1928, p. 456]. Carapace about as long as wide, moderately vaulted longitudinally, transversely; carapace regions well defined, ornamented with large tubercles; orbits with two fissures and with inner-, intra-, and outer-orbital spines; rostrum poorly known, axially sulcate; short, convex suborbital region positioned laterally and distally to orbits; orbits positioned above anterolateral margins, separated from them by suborbital area; anterolateral margins with broadly spaced spines of about equal size; posterolateral margins with one spine; cervical, branchiocardiac grooves well defined, branchial region with sharp tubercles not on raised ridges; axial regions generally wide, urogastric region short. [Emended from SCHWEITZER, KARASAWA, & others, 2016, p. 349.] *Lower Cretaceous (Aptian)–Upper Cretaceous (Campanian):* Japan, *Aptian;* Ukraine (Crimea), UK (England), *Albian;* France, UK (England), *Cenomanian;* Germany, *Santonian–Campanian;* USA (New Jersey), *Campanian*.——FIG. 4,*1a–b*. **N. labeschii* (EUDES-DESLONGCHAMPS), SM B23152, Albian, England; dorsal (*a*) and ventral (*b*) views, scale bars, 1 cm (Karasawa, Schweitzer, & Feldmann, 2011, fig. 10A–B).

Arcticocarcinus SCHWEITZER, KARASAWA, & others, 2016, p. 352 [**Necrocarcinus insignis* SEGERBERG, 1900, p. 26, pl. III,*1,6;* OD]. Carapace slightly wider than long, length about 90 percent maximum carapace width, widest about one-quarter the distance posteriorly; suborbital region with spines; anterolateral margin with a few short spines and one conspicuously long spine marking maximum width; posterolateral margin long, with one conspicuously long spine; fronto-orbital width about 60 percent of carapace width; axial regions with short, wide metagastric and cardiac region, and conspicuously narrow urogastric region; tubercles on branchial region appearing to be on ridge on smaller specimens, with ridge obsolete in large specimens. [Emended from SCHWEITZER, KARASAWA, & others, 2016, p. 353.] *Paleocene (Danian):* Sweden.——FIG. 4,*2*. **A. insignis* (SEGERBERG), holotype, LO 1551t, dorsal carapace, scale bar, 1 cm (Schweitzer, Karasawa, & others, 2016, fig. 6A).

Elektrocarcinus SCHWEITZER, KARASAWA, & others, 2016, p. 354 [**Campylostoma pierrense* RATHBUN, 1917, p. 389, pl. 33,*4–5;* OD]. Carapace about as wide as long, moderately vaulted transversely, longitudinally; anterolateral, posterolateral margin with widely spaced, sharp spines; rostrum projected beyond orbits, proximally rectangular with spine on each side and distally triangular with bifid tip; intra- and inner-orbital spines short, orbital fissures short; outer-orbital spine well developed; concave suborbital region positioned laterally and distally to orbit; orbits weakly upturned, positioned above anterolateral margins, separated from margins by suborbital area; branchial regions with arcuate ridge arising on epibranchial region, extending into ridge or row of spines, parallel to axis, then extending posterolaterally, intersecting last posterolateral spine; intestinal and cardiac regions long. Chela with spines on upper margin, discontinuous keel on outer margin; long, slender fingers. [Emended from SCHWEITZER, KARASAWA, & others, 2016, p. 354.] *Lower Cretaceous (Albian)–Upper Cretaceous (Maastrichtian):* UK (England), USA (Texas), *Albian;* UK (England), *Cenomanian–Turonian;* USA (South Dakota), *Turonian, Campanian–Maastrichtian*.——FIG. 4,*3*. **E. pierrensis* (RATHBUN), cast of USNM 73567, numbered KSU D 1464, Campanian–Maastrichtian, South Dakota, USA, scale bar, 1 cm (Schweitzer, Karasawa, & others, 2016, fig. 6B).

Hadrocarcinus SCHWEITZER, FELDMANN, & LAMANNA, 2012, p. 150 [**Necrocarcinus wrighti* FELDMANN, TSHUDY, & THOMSON, 1993, p. 35, fig. 29,*1–5;* OD]. Carapace about as wide as long, widest about 40 percent of the distance posteriorly on carapace; rostrum trifid, middle spine downturned, outer two spines directed upward; orbits directed anteriorly or axially; fronto-orbital width about 44 percent maximum carapace width; anterolateral margins set below level of rostrum and orbits, with between four and six spines, excluding outer-orbital spine, most appearing to be broad and triangular, but last spine long, directed laterally; posterolateral margin with two spines near posterolateral corner; posterior margin narrow, convex; carapace regions very well defined, most ornamented with stout spines; cervical groove deep, sinuous, bounding posterior margins of protogastric and hepatic regions; branchiocardiac groove shallower than cervical groove, bounding posterior margin of epibranchial region; postcervical groove only present as deep lateral margin of metagastric region; chelipeds appearing to be heterochelous at least in terms of length; sternum deep, narrow; sternites 1–3 fused, long

sternite 4 with steep lateral sides, deep axially; pleon with axial keel; somite 6 very long. [Emended from Schweitzer, Feldmann, & Lamanna, 2012, p. 152.] *Upper Cretaceous (Santonian–Maastrichtian):* Antarctica (Peninsular).——Fig. 4,*4a–b.* **H. wright* (Feldmann, Tshudy, & Thomson); *a,* cast of holotype, BAS In.2237, numbered KSU D 1015, dorsal view, scale bar, 1 cm (Schweitzer, Feldmann, & Lamanna, 2012, fig. 3A); *b,* cast of paratype, CIRGEO 882, numbered KSU D 1914, ventral view, scale bar, 1 cm (Schweitzer, Feldmann, & Lamanna, 2012, fig. 3B).

Family ORITHOPSIDAE Schweitzer, Feldmann, Fam, Hessin, Hetrick, Nyborg, & Ross, 2003

[Orithopsidae Schweitzer & others, 2003, p. 39] [=Juglocarcinidae Collins, Garvie, & Mellish in Garvie, Collins, & Mellish, 2017, p. 19]

Carapace hexagonal or ovate, slightly wider than long, widest at position of last anterolateral spine, about half the distance posteriorly; flattened longitudinally, transversely; regions defined as broad swellings, may have isolated tubercles; rostrum broad, projected well beyond orbits, with 2–4 spines; orbits with two fissures, directed forward; inner-, intra-, outer-orbital spines well developed; fronto-orbital width typically about half maximum carapace width, but wider in some species; anterolateral margins short, usually with numerous spines; posterolateral margin entire or with spines; protogastric regions narrow, sometimes with small nodes or elongate, reniform swellings; metagastric region without tubercles; hepatic regions wide, sometimes with small nodes or elongate, reniform swellings. Cervical groove moderately well developed, arcuate; branchiocardiac groove well developed, parallel to cervical groove; postcervical groove weak; secondary groove between cervical and branchiocardiac grooves nearly parallel to each, but joining cervical groove at about midwidth of protogastric region; epibranchial region developed as broad, arcuate, digitate swelling directed at urogastric region; axial region very weakly inflated, consisting of mesogastric, metagastric, cardiac, and long, depressed urogastric regions; axis may have longitudinal ridge; mesobranchial and metabranchial regions without tubercles. Sternite 2 small, pentagonal; sternite 3 triangular, separated from sternite 4 by axial grooves; sternite 4 flattened axially, raised laterally, sternal suture 4/5 incomplete, deep, and straight, then turning at nearly right angle, oriented parallel to axis of animal axially; sternite 5 wider than long, articulating with pereiopod 2, directed laterally, sternal suture 5/6 incomplete, deep, straight, then turning at nearly right angle, oriented parallel to axis of individual axially; sternite 6 directed posterolaterally, sternal suture 6/7 incomplete, deep, arcuate, oriented parallel to axis of animal axially; sternite 7 reduced, with bulge anteriorly and axially, suture 7/8 appearing to be complete; sternite 8 reduced, vertical, visible only in posterior view; all pleonites free in females, with blunt axial ridge on each somite; somite 6 much longer than wide, telson extending to level of middle of somite 4 in female. [Emended from Schweitzer, Karasawa, & others, 2016, p. 355.] *Lower Cretaceous (Aptian)–Oligocene (Rupelian).*

Orithopsis Carter, 1872, p. 530, pl. 13,*1* [**O. bonneyi;* M]. Carapace hexagonal, about as wide as long; front projecting well beyond orbits; central spine trifid, with two spines to either side of central spine, largest forming inner-orbital spine; large, triangular intraorbital spine; outer-orbital spine stout, wrapping around outer-orbital angle; anterolateral margins with four spines, excluding outer-orbital spine; carapace axially keeled; protogastric regions ornamented with tubercles; epibranchial region arcuate; branchial region with longitudinal keel subparallel to axial keel. [Emended from Karasawa & others, 2014, p. 238.] *Lower Cretaceous (Albian)–Upper Cretaceous (Maastrichtian):* UK (England), *Albian;* Kazakhstan, UK (England), *Cenomanian;* Czech Republic, *Turonian;* The Netherlands, *Maastrichtian.*——Fig. 5,*1a.* **O. bonneyi,* holotype, SM B 58557, dorsal view, *Albian–Cenomanian,* England, scale bar, 2 cm (Karasawa & others, 2014, fig. 8A).——Fig. 5,*1b. O. tricarinatus* Bell, 1863, SM B 23259, dorsal view, Albian–Cenomanian, England, scale bar, 1 cm (Karasawa & others, 2014, fig. 8C).

Aetocarcinus Schweitzer, Feldmann, & others, 2016, p. 15 [**Diaulax roddai* Bishop, 1983, p. 45, pl. 1,*1–2;* OD; =*Pseudonecrocarcinus stenzeli* Bishop, 1983, p. 49, pl. 1,*3–5*] [=*Juglocarcinus* Collins, Garvie, & Mellish in Garvie, Collins, & Mellish, 2017, p. 19 (type, *J. tumulus,* p. 19, fig. 3, OD)]. Carapace about as wide as long; rostrum extending well beyond orbits and broadly sulcate axially; distal half triangular, apparently blunt tipped and strongly downturned to be at

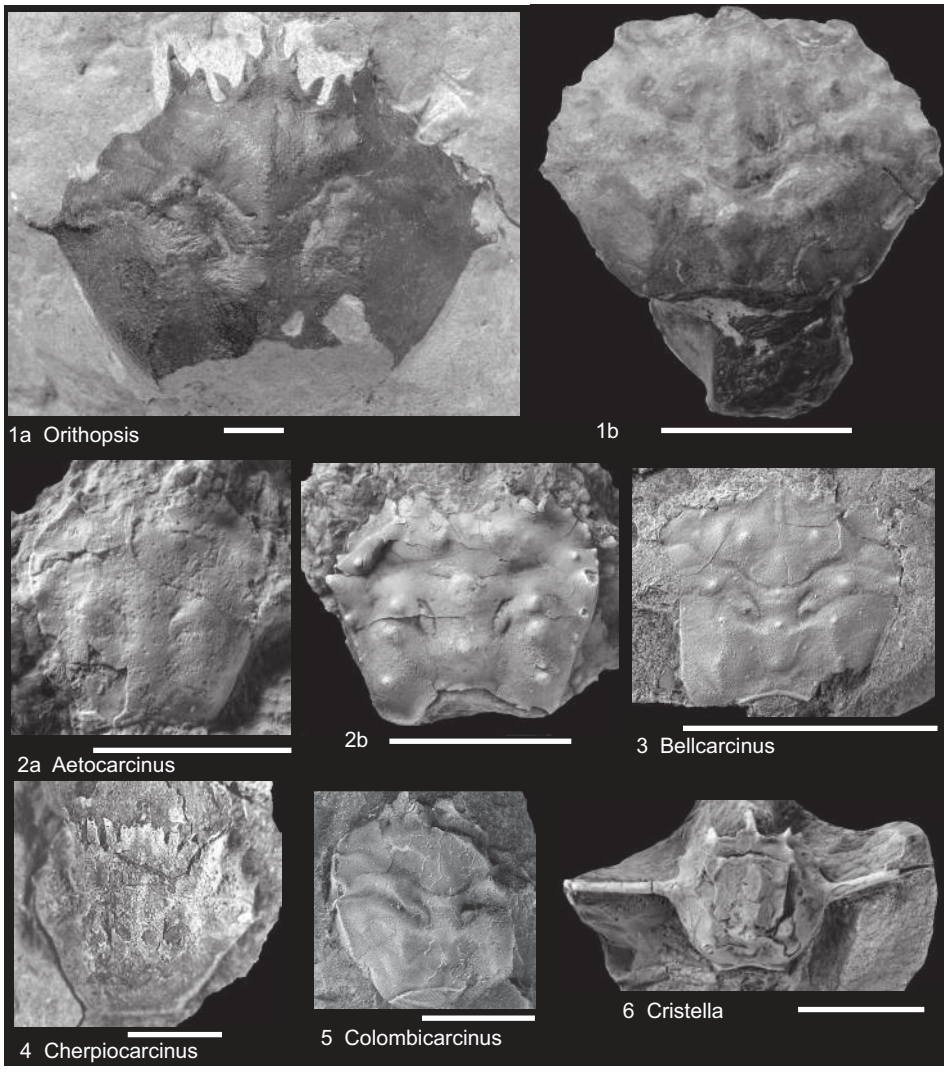


FIG. 5. Orithopsidae (p. 8–10).

high angle to carapace; proximal half with flared rim, rectangular; orbits with two orbital fissures; outer-orbital spine broad, triangular; fronto-orbital width about 60 percent maximum carapace width; anterolateral margins short, with about seven spines excluding outer-orbital spines; cervical groove better developed than postcervical and branchiocardiac grooves; carapace smooth or with tubercles, always with broadly inflated branchial ridge subparallel to axis. [Emended from SCHWEITZER, FELDMANN, & others, 2016, p. 15.] *Lower Cretaceous (Albian):* USA (Texas).——FIG. 5,*2a*. **A. roddai* (BISHOP), SDSNH 23640, dorsal view, scale bar, 1 cm (Schweitzer, Feldmann, & others, 2016, fig. 9,*1*).——FIG. 5,*2b*. *A. muricatus* SCHWEITZER, FELDMANN, & others, 2016, holotype, TMM NPL 69683, dorsal view, scale bar, 1 cm (Schweitzer, Feldmann, & others, 2016, fig. 10).

Bellcarcinus LUQUE, 2014, p. 28, pl. 1 [**B. aptiensis*; OD]. Carapace subhexagonal, slightly wider than long; maximum width at about mid-length; maximum length at about 80 percent carapace width, measured from center of posterior margin to base of rostrum. Fronto-orbital margin broad, about 55 percent carapace width. Orbits wide, directed forwards, with two, short, widely spaced orbital fissures; intraorbital spine short, broad, truncated. Anterolateral margin with four small, triangular spines, excluding outer-orbital spine; posterolateral margins long, slightly convex,

apparently lacking posterolateral spines; posterior margin wide, about 45 percent carapace width and nearly as wide as fronto-orbital margin, concave. Post-rostral slits absent; cervical and branchiocardiac grooves distinct and well developed, reaching anterolateral margins; postcervical groove absent. Dorsal carapace axially bearing row of tubercles; carapace axially keeled; protogastric regions ornamented with tubercles; branchial region with longitudinal ridge, the anterior half slightly concave and posterior half slightly convex. [Emended from Luque, 2014, p. 28]. *Lower Cretaceous (Aptian):* Colombia.——Fig. 5,*3*. **B. aptiensis,* holotype, IGM p881107, dorsal view, scale bar, 1 cm (Luque, 2014, pl. 1,*1*).

Cherpiocarcinus Marangon & De Angeli, 1997, p. 100, pl. 1 [**C. rostratus;* OD). Carapace hexagonal, as long as wide, with three anterolateral spines; front triangular with long axial spine and lateral spines; orbits with two, very long fissures bounding two, very long intraorbital spines; outerorbital spine bifid, longer than rostrum; regions variously defined; one gastro-cardiac keel and three longitudinal protogastric keels; surface granular. [Karasawa & others, 2014, p. 237.] *Oligocene (Rupelian):* Italy.——Fig. 5,*4*. **C. rostratus,* holotype, MCZ 1548, dorsal view, scale bar, 1 cm (new; photo by A. De Angeli, Associazione del Museo Zannato, Montecchio Maggiore (Vicenza), Italy).

Colombicarcinus Karasawa & others, 2014, p. 236, fig. 7 [**C. laevis;* OD]. Carapace nearly equidimensional, with maximum width in anterior third; maximum length about 80 percent carapace width, measured from posterior margin to base of rostrum. Fronto-orbital margin broad, about 55 percent carapace width. Orbits relatively wide for a necrocarcinid and directed forward, with two, short, widely spaced orbital fissures; intraorbital spine short, broad, truncated. Anterolateral margin with at least three, short, and unequal spines, excluding outer-orbital spine; posterolateral margins long, slightly convex, and finely granulated, lacking posterolateral spines; posterior margin concave, rimmed, shorter than fronto-orbital margin; apparently sexually dimorphic, with carapace width about 50 percent carapace in female and about 40 percent in male. Post-rostral slits absent; cervical and branchiocardiac grooves distinct, well developed, reaching anterolateral margins; postcervical groove absent. Dorsal carapace smooth, weakly ornamented, lacking axial ridge or row of tubercles; branchial region lacking conspicuous longitudinal ridge. [Emended from Karasawa & others, 2014, p. 236.] *Lower Cretaceous (Aptian):* Colombia.——Fig. 5,5. **C. laevis,* IGM p881167, holotype, dorsal view, Aptian, Colombia, scale bar, 1 cm (Karasawa & others, 2014, fig. 7A).

Cristella Collins & Rasmussen, 1992, p. 36, fig. 20 [**C. hastata;* OD]. Carapace hexagonal, about as wide as long; front with long central spine and possibly a smaller spine on either side; orbits deep, closely spaced; orbital margin with several spines; anterolateral margin with at least two spines, last spine (may be equivalent to epibranchial spine) longer than carapace width. [Emended from Karasawa & others, 2014, p. 233.] *Paleocene (Danian):* Greenland.——Fig. 5,*6*. **C. hastata,* cast of holotype, MGUH 21.611, numbered KSU D 1807, dorsal view, scale bar, 1 cm (Schweitzer, Feldmann, & others, 2016, fig. 9C).

Marycarcinus Schweitzer & others, 2003, p. 40 [**Necrocarcinus hannae* Rathbun, 1926a, p. 84, pl. 18,*1–2;* OD]. Carapace about as wide as long, widest about one-third of distance posteriorly on carapace; rostrum with four, small spines; intraorbital spine bounded on either side by deep, open orbital fissure; outer-orbital spine bifid with outer tip longer than inner tip; fronto-orbital width about 65 percent maximum carapace width; anterolateral margin with two or three, small spines; branchial regions with arcuate ridge convex axially, terminating in a tubercle. [Emended from Schweitzer & others, 2003, p. 40.] *Eocene:* USA (California, Oregon).——Fig. 6,*1*. **M. hannae* (Rathbun), holotype, CAS 2813, dorsal view, Eocene, California, scale bar, 1 cm (Rathbun, 1926a, pl. 18,*1*).

Paradoxicarcinus Schweitzer & others, 2003, p. 42, fig. 14 [**P. nimonoides;* OD]. Carapace, excluding spines, about as long as wide; cervical groove very deep; branchiocardiac groove deep axially and not developed laterally; front bifid; anterolateral margin with three, long, attenuated spines; branchial regions with one, transverse and one, longitudinal swelling. [Emended from Schweitzer & others, 2003, p. 43.] *Upper Cretaceous (Santonian):* Canada (British Columbia).——Fig. 6,*2*. **P. nimonoides,* holotype, GSC 124826, dorsal view, scale bar, 1 cm (Schweitzer & others, 2003, fig. 14,*3*).

Paradoxilissopsa Schweitzer, Dworschak, & Martin, 2011, p. 362 [**Lissopsis transiens* Frič in Frič & Kafka, 1887, p. 48, pl. 10,*7;* M] [=*Lissopsis* Frič in Frič & Kafka, 1887, p. 48, *non Lissopsis* Wollaston, 1873 (Coleoptera), *nec Lissopsis* Warren, 1894 (Lepidoptera)]. Carapace about as long as wide, angular; rostrum projected well beyond orbits, spatulate; orbits deep, rimmed, with stout outer-orbital spine; anterolateral margin short, with several spines; posterolateral margin longer than anterolateral margin; posterior margin long, sinuous; carapace with axial keel; regions broadly inflated; branchial regions with longitudinal keels. [Karasawa & others, 2014, p. 238.] *Upper Cretaceous (Turonian):* Czech Republic.——Fig. 6,*3*. **P. transiens* (Frič), holotype, PKNM O 4010, dorsal view, scale bar, 1 cm (Frič & Kafka, 1887, pl. 10,*7a*).

Planocarcinus Luque & others, 2012, p. 408 [**Dakoticancer olssoni* Rathbun, 1937a, p. 26, pl. 5,*6;* OD]. Carapace subcircular, slightly wider than long; with distinct cervical, postcervical, and branchiocardiac grooves; fronto-orbital margin as long as posterior margin; rostrum bilobate, spatulate, wider than long; orbits narrow, upturned, with two, short orbital fissures; anterolateral margin concave, with at least five spines; posterolateral margin convex, entire; posterior margin straight to concave; hepatic region depressed; metabranchial region inflated, lacking nodules or ridges. [Luque

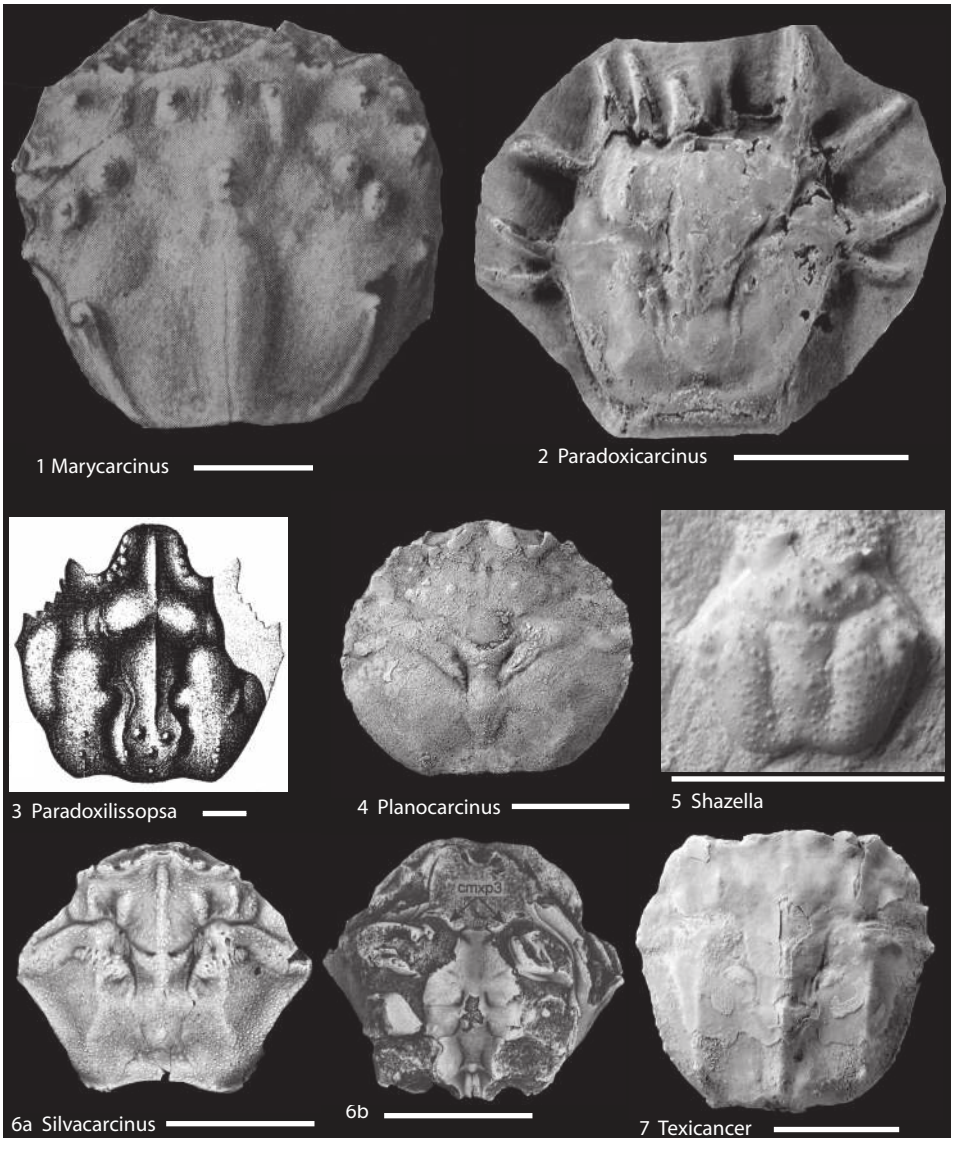


FIG. 6. Orithopsidae (p. 10–12).

& others, 2012, p. 408.] *Lower Cretaceous (Aptian):* Colombia.——FIG. 6,*4*. **P. olssoni* (RATHBUN), USNM 495104, holotype, dorsal view, scale bar, 1 cm (adapted from Luque & others, 2012, fig. 3A).

Shazella COLLINS & WILLIAMS, 2004, p. 34, fig. 1 [**S. abbotsensis;* OD]. Carapace hexagonal, with large, inflated, and pustulose mesogastric region; cervical groove extending onto flanks and very deep, except axially; branchial region undifferentiated, strongly inflated, with central, elongate swelling and swelling at lateral margin; cardiac region elongate, inflated; branchiocardiac groove parallelling lateral margins of cardiac region; posterior margin deeply concave. [Emended from KARASAWA & others, 2014, p. 236.] *Upper Cretaceous (Turonian):* UK (England).——FIG. 6,*5*. **S. abbotsensis,* holotype, (BMNH) IC 306, dorsal view, scale bars, 1 cm (Schweitzer, Karasawa, & others, 2016, fig. 9E).

Silvacarcinus COLLINS & SMITH, 1993, p. 263, pl. 2,*1–2,4–6* [**S. laurae;* OD]. Carapace hexagonal, about as wide as long; apparently with a narrow intraorbital spine; outer-orbital spine stout; anterolateral margins with three or four spines, excluding outer-orbital spine; carapace axially keeled;

protogastric regions ornamented with tubercles; epibranchial region arcuate; branchial region with longitudinal keel subparallel to axial keel; male sternum narrowly ovate. [Karasawa & others, 2014, p. 239.] *Eocene (Ypresian):* Belgium.——Fig. 6,*6a–b*. **S. laurae,* holotype, IRScNB-TCCI6115; dorsal (*a*) and ventral (*b*) views, scale bars, 1 cm (new; photos by B. W. M. Van Bakel, Oertijdmuseum De Groene Poort, Boxtel, The Netherlands).

Texicancer Franţescu, Feldmann, & Schweitzer, 2016, p. 1121 [**Necrocarcinus renfroae* Stenzel, 1945, p. 443, pl. 41,*13;* OD]. Carapace hexagonal, wider than long, widest at position of last anterolateral spine, and moderately vaulted transversely and longitudinally; fronto-orbital width approximately 60 percent of maximum width; regions weakly defined; protogastric regions with small nodes; branchial regions with longitudinal ridge; axial regions with longitudinal ridge. [Emended from Franţescu, Feldmann, & Schweitzer, 2016, p. 1121–1122.] *Lower Cretaceous (Albian):* USA (Texas).——Fig. 6,*7*. **T. renfroae* (Stenzel) USNM 558998, dorsal view, scale bar, 1 cm (Franţescu, Feldmann, & Schweitzer, 2016, fig. 4.1).

Family PARANECROCARCINIDAE Fraaije & others, 2008

[*nom. transl.* Schweitzer, Karasawa, & others, 2016, p. 357, *pro* Paranecrocarcininae Fraaije & others, 2008, p. 201]

Carapace hexagonal or ovate, slightly wider than long, widest at position of last anterolateral spine (about 40 to 50 percent of the posterior distance), moderately vaulted longitudinally and transversely or flattened; regions defined as broad swellings, ornamented with large, broad tubercles or numerous, small tubercles and granules; rostrum broad and sulcate and/or spatulate; orbits with two fissures, directed forward; outer-orbital spine may be well developed; inner-orbital spine positioned anteriorly; fronto-orbital width about 40 to 55 percent of maximum carapace width; infra-orbital lobe (*sensu* Van Bakel & others, 2012) present; two or four longitudinal depressions (slits) not penetrating through cuticle may be present on epigastric regions but not in all genera; anterolateral margins long, with numerous, small spines; posterolateral margin entire or fringed with small spines; cervical groove weak, appearing to possess weak secondary groove anterior to cervical groove starting about halfway along anterolateral margin and extending straight onto carapace before making a nearly 90° turn posteriorly to meet cervical groove; branchiocardiac and postcervical grooves absent; epibranchial region developed as broad, arcuate swelling or not differentiated; axial regions moderately inflated to flattened, consisting of depressed mesogastric, short metagastric, and short cardiac regions, and, if present, short urogastric regions; protogastric regions inflated; hepatic regions depressed. [Emended from Schweitzer, Karasawa, & others, 2016, p. 358.] *Lower Cretaceous (?Berriasian–Hauterivian)–Upper Cretaceous (Maastrichtian).*

Paranecrocarcinus Van Straelen, 1936, p. 36, pl. 4,*6–7* [**P. hexagonalis;* M] Carapace ovate, ornamented with large, broad swellings on axial, protogastric, and branchial regions; moderately vaulted longitudinally and transversely; fronto-orbital width about half maximum carapace width; orbits directed forward, slightly upturned; rostrum axially sulcate; anterolateral margin may have minute, blunt spines or have large, blunt anterolateral spine at anterolateral angle; posterolateral margin with blunt spine posterior to anterolateral angle, with remainder entire; epigastric regions may have two or four, weak, elongate slits; protogastric regions with one tubercle; cervical groove moderately developed, wide; branchiocardiac groove only developed along axis. [Emended from Schweitzer, Karasawa, & others, 2016, p. 360.] *Lower Cretaceous (?Berriasian–Hauterivian)–Upper Cretaceous (Cenomanian):* France, *Berriasian–Hauterivian;* France, Lebanon, Mozambique, *Cenomanian*.——Fig. 7,*1*. *P. mozambiquensis* Förster, 1968, holotype, BSP 1969 I 182, dorsal view, Cenomanian, Mozambique, scale bar, 1 cm (Schweitzer, Karasawa, & others, 2016, fig. 12A).

Protonecrocarcinus Förster, 1968, p. 178 [**Necrocarcinus ovalis* Stenzel, 1945, p. 442, pl. 41,7–9; OD]. Carapace ovate to hexagonal, wider than long, 75 to 85 percent maximum carapace width, and flattened longitudinally and transversely; rostrum downturned, apparently with single-spined tip bounded by inner-orbital projections; orbits with two fissures, inner shorter than outer; anterolateral margin with numerous spines; posterolateral with one spine; cervical groove deep axially; epibranchial region arcuate, ornamented with large swellings; weak linear branchial swelling subparallel to cardiac region, extending from posterolateral corner to about midlength of cardiac region. Emended from Schweitzer & others, 2017, p. 102.] *Upper Cretaceous (Turonian):* USA (New Mexico, Texas).——Fig. 7,*2*. **P. ovalis* (Stenzel), UT BEG 20196, dorsal view, Turonian, Texas, scale bar, 1 cm (Schweitzer, Karasawa, & others, 2016, fig. 12B).

Pseudonecrocarcinus Förster, 1968, p. 180 [**Necrocarcinus quadriscissus* Noetling, 1881, p. 368, pl. 20,*4;* OD]. Carapace hexagonal, granular

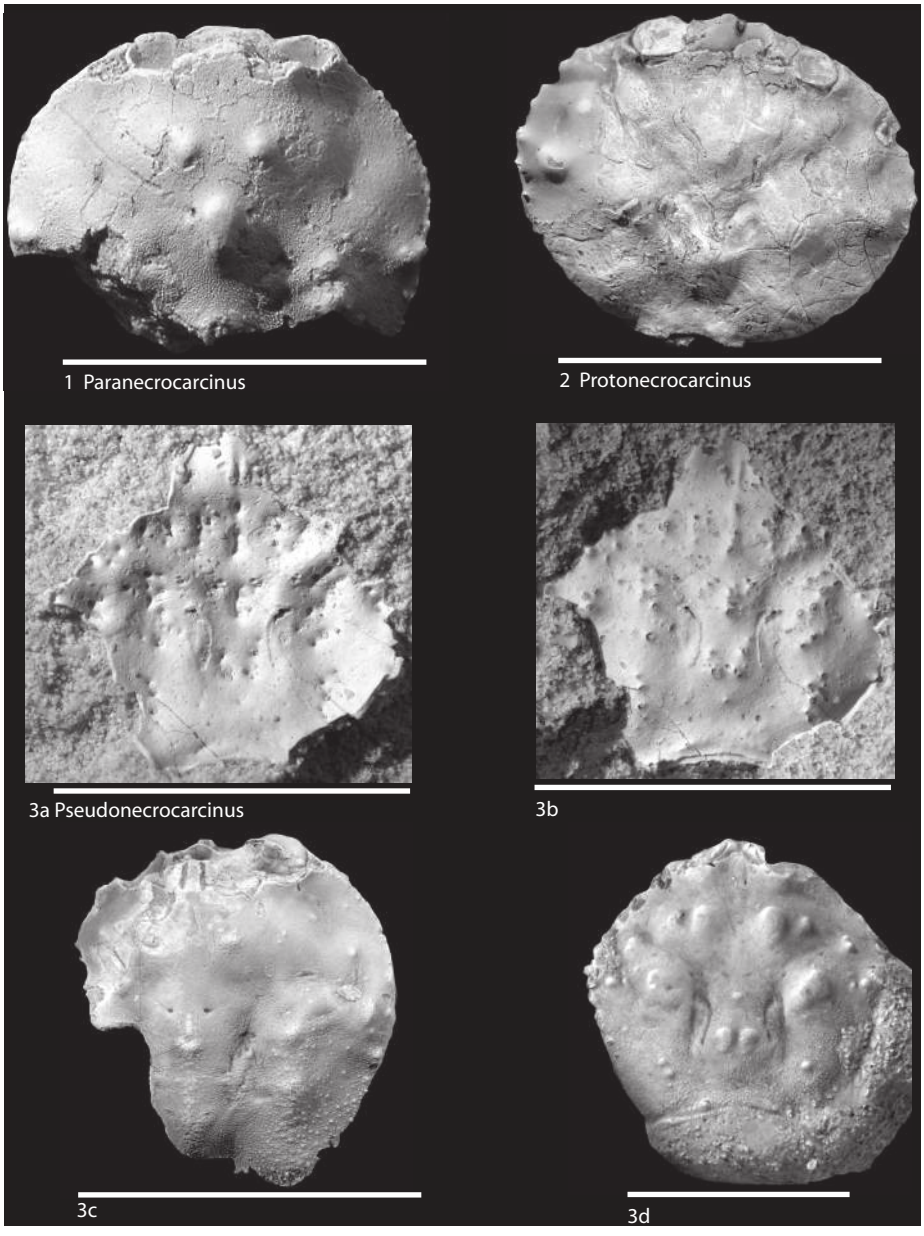


FIG. 7. Paranecrocarcinidae (p. 12–14).

overall, regions ornamented with tubercles and broad swellings, flattened longitudinally, and moderately vaulted transversely; rostrum axially sulcate, may have two or four spines; orbits not upturned; anterolateral margins with numerous small spines, posterolateral margins with several spines, sometimes entire in posterior half; fronto-orbital width 40 to 50 percent maximum carapace width; epigastric region usually with four, sometimes two, well-developed, elongate slits; tubercle present on epibranchial region between cervical and secondary grooves. [Emended from SCHWEITZER, KARASAWA, & others, 2016, p. 362.] *Lower Cretaceous (Albian)–Upper Cretaceous (Maastrichtian):* USA (Texas), *Albian;* France, Nigeria, UK (England), *Cenomanian;* USA (New Jersey),

Santonian; The Netherlands, *Maastrichtian*.——Fig. 7,*3a–b*. **P. quadriscissus* (Noetling), KSU D 2227, Maastrichtian, The Netherlands; *a*, inner surface of carapace; *b*, same specimen illuminated from lower right, scale bars, 1 cm (Schweitzer, Karasawa, & others, 2016, fig. 12C–D).——Fig. 7,*3c*. *P. moseleyi* (Stenzel, 1945), holotype, UT BEG 21095, dorsal view, Albian, Texas, scale bar, 1 cm (Schweitzer, Karasawa, & others, 2016, fig. 12E).——Fig. 7,*3d*, *P. gamma* (Roberts, 1962), holotype, ANSP 20031, dorsal view, Santonian, New Jersey, scale bar, 1 cm (Schweitzer Karasawa, & others, 2016, fig. 12F).

Superfamily PALAEOCORYSTOIDEA Lőrenthey in Lőrenthey & Beurlen, 1929

[*nom. transl.* van Bakel & others, 2012, p. 14, *pro* Palaeocorystinae Lőrenthey in Lőrenthey & Beurlen, 1929, p. 299]

Diagnosis and ranges as for family.

Family PALAEOCORYSTIDAE Lőrenthey in Lőrenthey & Beurlen, 1929

[*nom. transl.* Karasawa, Schweitzer, & Feldmann, 2011, p. 551, *pro* Palaeocorystinae Lőrenthey in Lőrenthey & Beurlen, 1929, p. 299]

Carapace obovate, usually longer than wide, widest at position of third or fourth anterolateral spine; frontal margin wide; anterolateral margin usually with two to four spines but may have more; carapace surface ornamented with ridges, straps, and tubercles or unornamented; epibranchial region with weak tooth; fronto-orbital margin and orbits wide, orbital margin with two fissures; rostrum generally long, with two spines at tip; orbits with inner, intra-, and outer-orbital spines, some of which may be bifid; gymnopleuran condition absent; sternites 1–3 fused, with 1 and 2 directed downward; sternite 4 long, pereiopod 1 articulating near posterior corner, moderately wide, lateral margins concave; sternal suture 4/5 sinuous laterally, then turning abruptly anteriorly parallel to axis; episternite 4 usually laterally directed but may be posteriorly directed (*Notopocorystes*); sternites 4/5 usually in broad contact (except *Notopocorystes*); sternite 5 long, moderately wide, with double-peg structure on episternal projection for attachment of pleon and episternites directed laterally or posterolaterally (*Notopocorystes*); sternal suture 5/6 complete; all female pleonites free, pleonite 6 long, pleonites 2–5 with central spine, entire pleon reaching to level of base of coxae of first pereiopods; male pleon narrower, telson triangular, somite 6 long, reaching to level of base of coxae of pereiopods 2; pleonal holding mechanism consisting of a double-peg structure; longitudinal furrow on merus of maxilliped 3; chelae with long fingers; female gonopore coxal, small, round; spermatheca at end of suture 7/8, separated from one another; pereiopod 5 reduced in size. [Emended from Karasawa & others, 2014, p. 239.] *Lower Cretaceous (Aptian)–Upper Cretaceous (Maastrichtian).*

Notopocorystes M'Coy, 1849, p. 169 [**Corystes stokesi* Mantell, 1844, p. 514, fig. 168,*2;* SD Withers, 1928, p. 456; =*Notopocorystes mantelli* M'Coy, 1849, p. 170] [=*Palaeocorystes* Bell, 1863, p. 11, obj.]. Carapace longer than wide, widest at position of penultimate anterolateral spine, about 30 percent of the distance posteriorly; fronto-orbital margin wide, about 75 percent of maximum carapace width; rostrum axially keeled, composed of three elements including rimmed and bifid axial elements and rimmed inner-orbital spines lateral to axial element; simple or bifid intraorbital spines flanked by orbital fissures; outer-orbital spine long, may be bifid; anterolateral margin with many spines with broad bases; posterolateral margin straight, may have beaded rim; cervical groove sinuous, developed as three arcs and terminating before crossing midline; branchiocardiac groove developed as arcuate segments on either side of axis; hepatic region with distinct pair of swellings anteriorly just posterior to orbit; branchial region with weak, arcuate, strap-like ornament that may be developed as muscle scars; sternites 1–3 small; sternite 4 wide, directed laterally, in broad contact with sternite 5; episternite 4 wide; suture 4/5 incomplete, initially straight, then turning at right angles and parallel to axis; sternite 5 wide, episternite directed posteriorly, suture 5/6 incomplete, initially straight, then turning at right angles and parallel to axis; somite 6 smaller than 5, suture 6/7 incomplete, sternite 7 directed posterolaterally; sternite 8 appearing to be positioned perpendicular to sternite 7. [Emended from Karasawa & others, 2014, p. 242.] *Lower Cretaceous (Albian)–Upper Cretaceous (Maastrichtian):* Madagascar, UK (England), *Albian;* USA (Mississippi [claws only]), *Campanian–Maastrichtian*.——Fig. 8,*1a–b*. **N. stokesi* (Mantell), (BMNH) In. 39366, Albian, England; dorsal (*a*) and ventral (*b*) views of female, scale bars, 1 cm (Karasawa, Schweiter, & Feldmann, 2011, fig. 11C–D).

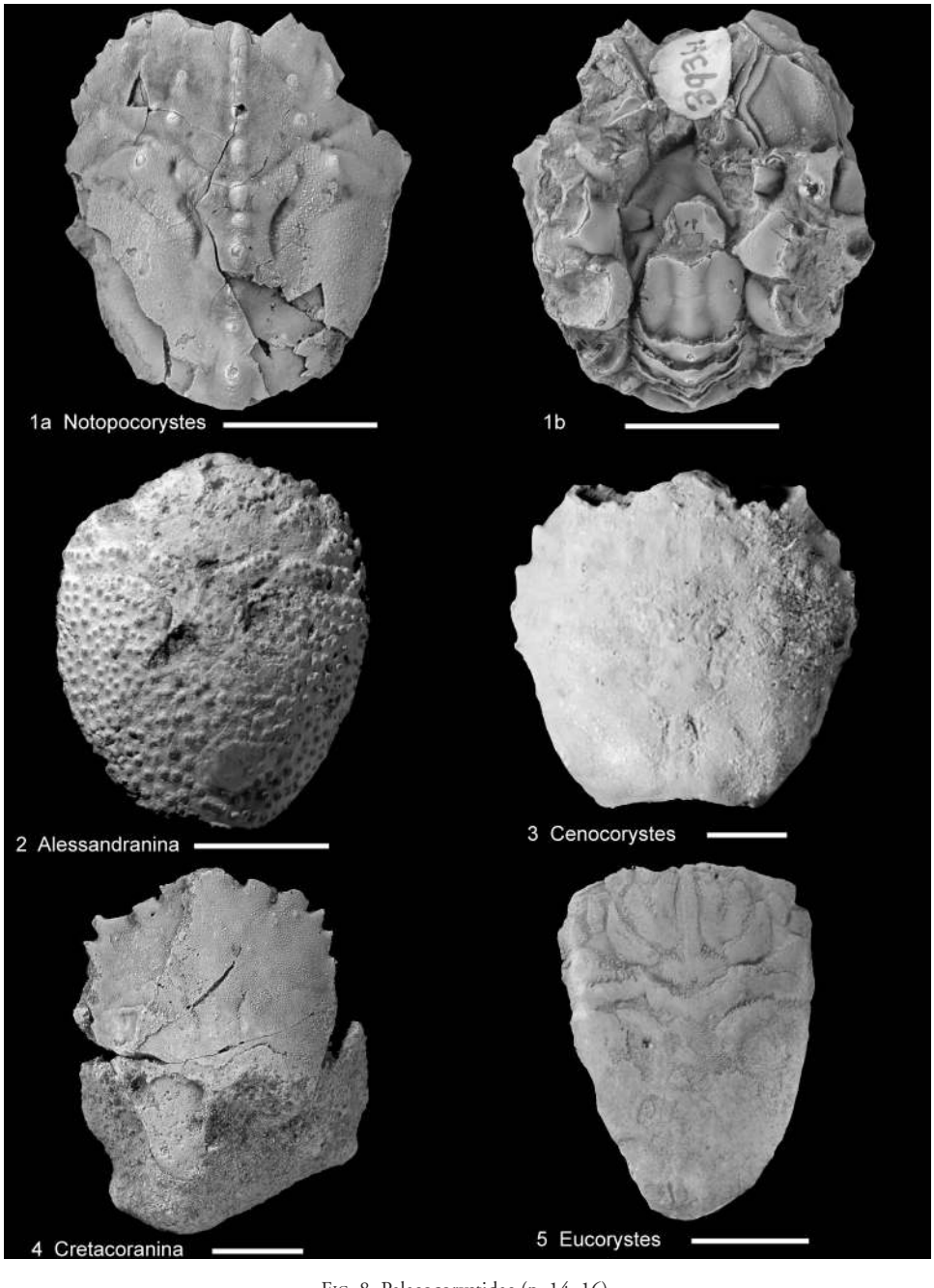


FIG. 8. Palaeocorystidae (p. 14–16).

Alessandranina KARASAWA & others, 2014, p. 242 [**Notopocorystes (Cretacoranina) ornatus* WRIGHT & COLLINS, 1972, p. 85, pl. 18,*4–5;* OD]. Carapace elongate, widest in anterior one-third; anterolateral margin appearing to have about four or five short, triangular, forward-directed spines; epibranchial region developed as a strap-like arc extending from anterolateral margin about two-thirds the distance axially; metagastric region wide and strap-like; mesogastric and protogastric regions not well

defined; hepatic regions with two triangular subregions; branchial regions broad, undifferentiated; all regions ornamented with large granules, most densely spaced on branchial regions. [Karasawa & others, 2014, p. 242.] *Upper Cretaceous (Cenomanian):* UK (England).——Fig. 8,*2. *A. ornata* (Wright & Collins), holotype, (BMNH) In. 61111, dorsal view, scale bar, 1 cm (Karasawa & others, 2014, fig. 9D).

Cenocorystes Collins & Breton, 2009, p. 45 [**C. fournieri;* OD]. Carapace about as long as wide, strongly vaulted; orbits shallow, directed forward; rostrum apparently trifid or with four spines; intraorbital spine long; outer-orbital spine longer than intraorbital spine; spines separated by wide fissures; anterolateral margin with three short spines; posterolateral margin with one short spine anteriorly; regions not well delimited; cervical and branchiocardiac grooves weak; pereiopod 5 small, subdorsal. [Emended from Karasawa & others, 2014, p. 239.] *Upper Cretaceous (Cenomanian):* France.——Fig. 8,*3. *C. fournieri,* holotype, MHN LM 2003-1-3813, dorsal carapace, scale bar, 1 cm (Collins & Breton, 2009; photo courtesy Bulletin of the Mizunami Fossil Museum).

Cretacoranina Mertin, 1941, p. 237 [**Raninella schloenbachi* Schlüter, 1879, p. 612, pl. 18,*2;* OD]. Carapace obovate, wide in anterolateral third; posterolateral margin narrowing considerably; rostrum sometimes rimmed, extending beyond orbital margin with bifid tip and spine just posterior to each spine at tip for a total of four, short spines on either side of rostrum forming inner-orbital spines; intraorbital spine bifid, bounded by fissures; outer-orbital spine bifid; anterolateral margin with 3 or 4 spines; spines becoming smaller posteriorly, last one nearly obsolete; cervical groove absent; branchiocardiac groove developed as arcs on either side of axis; dorsal carapace ornamentation developed as fungiform pillars overall but ending in indistinct, scalloped termination to base of orbital margin or just barely onto orbital margin and onto anterolateral spines; sternite 3 appearing triangular; sternite 4 wide, episternite 4 wide, in broad contact with sternite 5, directed laterally, suture 4/5 incomplete, straight; sternite 5 narrower than sternite 4. [Emended from Karasawa & others, 2014, p. 239.] *Upper Cretaceous (Coniacian–Maastrichtian):* Germany, UK (England), *Maastrichtian;* Czech Republic, Madagascar, *Coniacian–Maastrichtian;* Jamaica, USA (Tennessee, New Jersey), *Maastrichtian.*——Fig. 8,*4a–b. C. testacea* (Rathbun, 1926b), NJSM 23313, Maastrichtian, New Jersey; dorsal (*a*) and ventral (*b*) views, scale bars, 1 cm (Feldmann & others, 2013, fig. 11,*1–2*).

Eucorystes Bell, 1863, p. 17 [**Notopocorystes carteri* M'Coy, 1854, p. 118, pl. 4,*3;* M]. Carapace longer than wide; rostrum long with trifid central spine, middle spine of trifid central spine very short; two short spines on either side of rostrum forming inner-orbital spines; intraorbital spine short, blunt, bounded by fissures; outer-orbital spine bifid, wide; anterolateral margin with two or three spines and possibly various tubercles of varying degrees of development; posterolateral margin may have one anterior spine; anterior half of carapace ornamented with distinctive strap-like ornamentation in which the epibranchial strap extends across carapace (including metabranchial region), arcuate straps posterior to the epibranchial strap bound urogastric and cardiac regions, and mesogastric region developed into strap-like structures. Protogastric region ornamented with U-shaped strap and, posterior and lateral to it, an arcuate strap. Hepatic region generally has a series of smaller, raised swellings. Sternites 1–3 small; sternite 4 wide, episternite 4 wide, directed laterally, in broad contact with sternite 5, and with suture 4/5 incomplete, initially straight, then turning at right angles and parallel to axis; sternite 5 wide, episternite directed posteriorly, suture 5/6 complete; sternite 6 smaller than sternite 5. [Emended from Karasawa & others, 2014, p. 241.] *Lower Cretaceous (Albian)–Upper Cretaceous (Campanian):* Canada (British Columbia), France, Kazakhstan, Spain, UK (England), USA (Oregon), *Albian;* Australia (Northern Territory), Japan, *Cenomanian;* Canada (British Columbia), western Greenland, *Santonian–Campanian;* USA (Montana), *Campanian.*——Fig. 8,*5. *E. carteri* (M'Coy), cast of J. S. H. Collins Collection 2319f, numbered KSU D 1509, dorsal carapace, Albian, England, scale bar, 1 cm (Karasawa & others, 2014, fig. 9C).

Ferroranina van Bakel & others, 2012, p. 29 [**Notopocorystes dichrous* Stenzel, 1945, p. 438, pl. 43,*5–7,* fig. 13; OD]. Carapace ovate, not much longer than wide, widest at penultimate anterolateral spine, about 33 percent of the distance posteriorly; fronto-orbital width wide, about 75 percent of maximum width of carapace; rostrum composed of three elements, axially keeled, rimmed and bifid axial element is flanked by rimmed inner-orbital spines; intraorbital spines flanked by orbital fissures and spines (sometimes bifid); outer-orbital spine may be bifid, long; anterolateral margin with many, usually four, spines with broad bases; posterolateral margin straight, can have beaded rim; cervical groove developed as short, sinuous segments on either side of axis; branchiocardiac groove developed as arcuate segments on either side of axis; dorsal carapace ornamentation developed as fungiform pillars overall but ending in distinctive scalloped termination just before orbits and anterolateral spines; sternites 1–3 small; sternite 4 wide, episternite 4 wide, directed laterally, in broad contact with sternite 5, suture 4/5 incomplete, initially straight, then turning at right angles and parallel to axis; pleon with broad axial ridge. [Emended from Karasawa & others, 2014, p. 241.] *Upper Cretaceous (Cenomanian–Campanian):* India, *Cenomanian;* USA (Texas), *Turonian;* Madagascar, *Santonian–Campanian.*——Fig. 9,*1a–b. *F. dichrous* (Stenzel), Turonian, Texas; *a*, USNM 559024, dorsal view; *b*, USNM 559025, ventral view, scale bars, 1 cm (Frantescu, Feldmann, & Schweitzer, 2016, fig. 6,*2,8*).

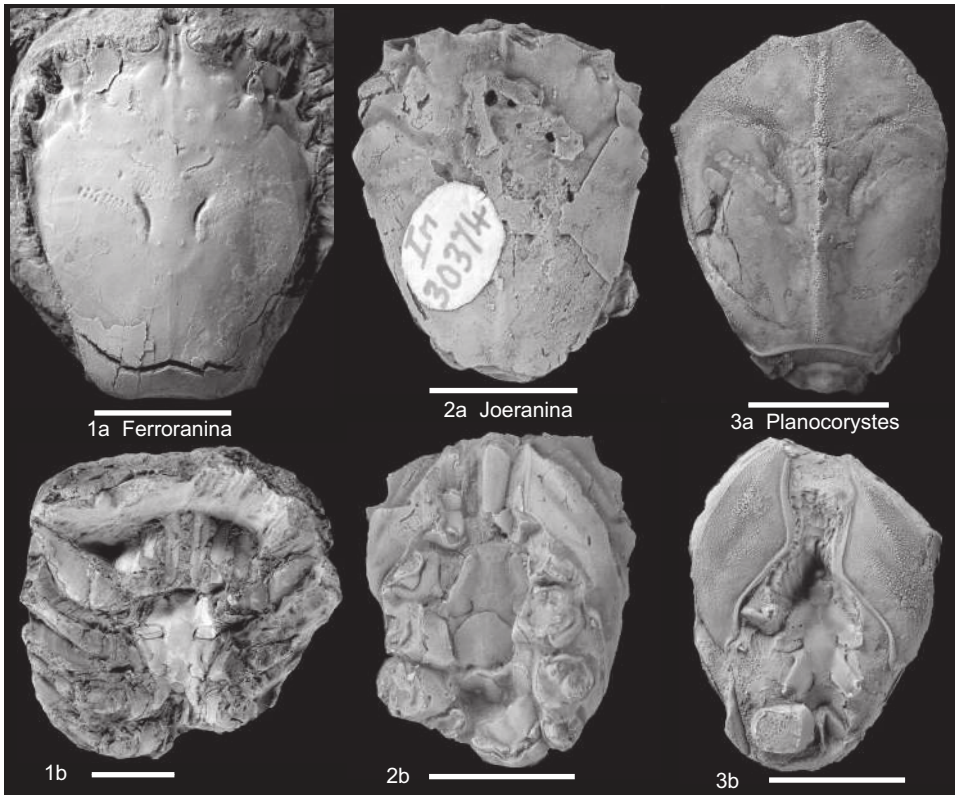


FIG. 9. Palaeocorystidae (p. 16–18).

Joeranina VAN BAKEL & others, 2012, p. 36 [**Corystes broderipi* MANTELL, 1844, p. 514, fig. 168,*3;* OD]. Carapace longer than wide, widest at position of penultimate anterolateral spine, about 30 percent of the distance posteriorly; fronto-orbital width wide, about 75 percent maximum width of carapace; rostrum composed of three elements, axially keeled, rimmed and bifid element is flanked by rimmed inner-orbital spines; intraorbital spines flanked by orbital fissures and spines (sometimes bifid); outer-orbital spine may be bifid, long; anterolateral margin with four or more spines with broad bases; posterolateral margin straight, may have beaded rim; cervical groove sinuous, developed as three arcs and terminating before crossing midline; branchiocardiac groove developed as arcuate segments on either side of axis; hepatic region with distinct pair of swellings anteriorly, just posterior to orbit; branchial region with weak, arcuate, strap-like ornament that may be developed as muscle scars; sternites 1–3 small; sternite 4 wide, episternite 4 wide, directed laterally, in broad contact with sternite 5, suture 4/5 incomplete, initially straight, then turning at right angles and parallel to axis; sternite 5 wide, episternite directed posteriorly, suture 5/6 incomplete, initially straight, then turning at right angles and parallel to axis; sternite 6 smaller than sternite 5, suture 6/7 incomplete; sternite 7 directed posterolaterally; sternite 8 appearing to be positioned perpendicular to sternite 7. [Emended from KARASAWA & others, 2014, p. 242.] *Lower Cretaceous (Aptian)–Upper Cretaceous (Santonian):* Colombia, *Aptian;* China, Colombia, Iran, Japan, Spain, UK (England), *Albian;* France, Syria, *Cenomanian;* Japan, *Cenomanian–Santonian*.——Fig. 9,*2a–b*. **J. broderipi* (MANTELL), (BMNH) In. 30374, Albian, England, dorsal *(a)* and ventral *(b)* views, scale bars, 1 cm (Karasawa & others, 2014, fig. 9A–B).

Planocorystes FRANȚESCU, FELDMANN, & SCHWEITZER, 2016, p. 1127, fig. 7 [**P. robreidi;* OD]. Carapace ovoid, ornamented with fine granules axially and laterally and bounding cervical groove; median carina extends entire length of carapace; fronto-orbital width about 45 percent maximum carapace width; cervical and branchiocardiac grooves weakly defined; carapace regions poorly defined and carapace lacking large nodes. Anterior margin of sternite 4 much broader than sternites 1–3; sternites 4 and 5 with similarly sized episternal projections; subdistal locking peg on sternite 5 larger than distal peg. [Emended from FRANȚESCU, FELDMANN,

& Schweitzer, 2016, p. 1127.] *Lower Cretaceous (Albian):* USA (Texas).——Fig. 9,*3a–b*. **P. robreidi,* holotype, USNM 559030, dorsal *(a)* and ventral *(b)* views, scale bars, 1 cm (Franţescu, Feldmann, & Schweitzer, 2016, fig. 7,*1–2*).

Superfamily RANINOIDEA de Haan, 1839

[Raninoidea de Haan, 1839 in 1833–1850, p. 102] [=Gymnopleura Bourne, 1922 p. 55]

Carapace longer than wide or about as wide as long, generally ovate, usually vaulted transversely, regions poorly defined, and usually with well-developed rostrum and orbital spines; anterolateral margins usually with one spine but can have none or more than one; posterolateral margin lacking spines; cervical groove, when present, not reaching ventral edge of carapace; branchiocardiac groove indistinct, developed as boundary for urogastric region; branchial ridges absent; junction between sternum and pterygostome usually wide; sternum narrow, sternites 1–3 generally fused, sternites 5 and 6 with lateral extensions, sternal suture 6/7 complete, sternites 7 and 8 often reduced and at lower level than other sternites; pleon, where known, narrow in males and females, showing reduced but clear dimorphism; genital openings coxal, paired spermatheca present on endosternite 7/8; coxa of third maxilliped small, flattened; branchiostegite reduced; gymnopleuran condition present. [Emended from Karasawa & others, 2014, p. 243.] *Lower Cretaceous (Albian)–Holocene.*

Family LYREIDIDAE Guinot, 1993

[*nom. transl.* Van Bakel & others, 2012, p. 75, *pro* Lyreidinae Guinot, 1993, p. 1326]

Carapace much longer than wide, oblanceolate; carapace surface smooth, regions undefined; anterior margin narrow or wide; rostrum trifid, middle spine generally much longer than other two, which serve as inner-orbital spines; orbit with intra- and outer-orbital spines; anterolateral margins may be entire or with one or two spines; sternum-pterygostome junction poorly to well developed or absent; gymnopleuran condition present; sternites 1–3 fused, forming a cap-like shape; sternite 4 large, with lateral extensions anteriorly, concave posteriorly; sternite 5 similar in shape to sternite 4, but smaller with lyreidid hook (Guinot, 1979) and double-peg abdominal locking mechanism; sternite 6 much smaller, sometimes with ridge; sternites 7 and 8 much reduced in size; pleon sexually dimorphic, narrower in males; somites 2 and 5 proportionally wider in females than males, somite 6 proportionally longer in females than males; spermatheca placed on sternite 7, separated by wall; merus of maxilliped three times longer than ischium. [Emended from Karasawa & others, 2014, p. 243–244.] *Lower Cretaceous (Albian)–Holocene.*

Lyreidina Fraaye & Van Bakel, 1998, p. 294, fig. 1a [**L. pyriformis;* M]. Carapace ovate, longer than wide, widest about two-thirds the distance posteriorly on carapace, moderately vaulted longitudinally and strongly vaulted transversely; rostrum blunt-triangular, with axial carina; inner-orbital spines very short. Orbits directed forward, intraorbital spine very short, rounded, not projecting much beyond orbital rim, longer than outer-orbital spine; outer-orbital spine very short, rounded; intraorbital spine bounded by closed fissures. Lateral margins convex, rimmed posteriorly; posterior margin narrow; carapace surface coarsely punctate posteriorly; very subtle Y-shaped epibranchial and cardiac swelling. [Karasawa & others, 2014, p. 256.] *Late Cretaceous (Maastrichtian):* The Netherlands.——Fig. 10,*1*. **L. pyriformis,* holotype MAB k. 2251, dorsal carapace, Maastrichtian, The Netherlands, scale bar, 1 cm (new).

Subfamily LYREIDINAE Guinot, 1993

[Lyreidinae Guinot, 1993, p. 1326]

Carapace much longer than wide, oblanceolate; dorsal surface smooth or punctate, regions undefined; anterior margin narrow, rostrum trifid with middle spine generally much longer than other two, which serve as inner-orbital spines; orbit with intra- and outer-orbital spines, supraorbital spine absent; fronto-orbital width less than one-half to two-thirds maximum carapace width in most taxa; anterolateral margins may be entire or with one or two spines, last spine long; sternum-pterygostome junction poorly to well developed; gymnopleuran condition present; sternites 1–3 fused, forming a cap-like shape; sternite 4 large, with lateral

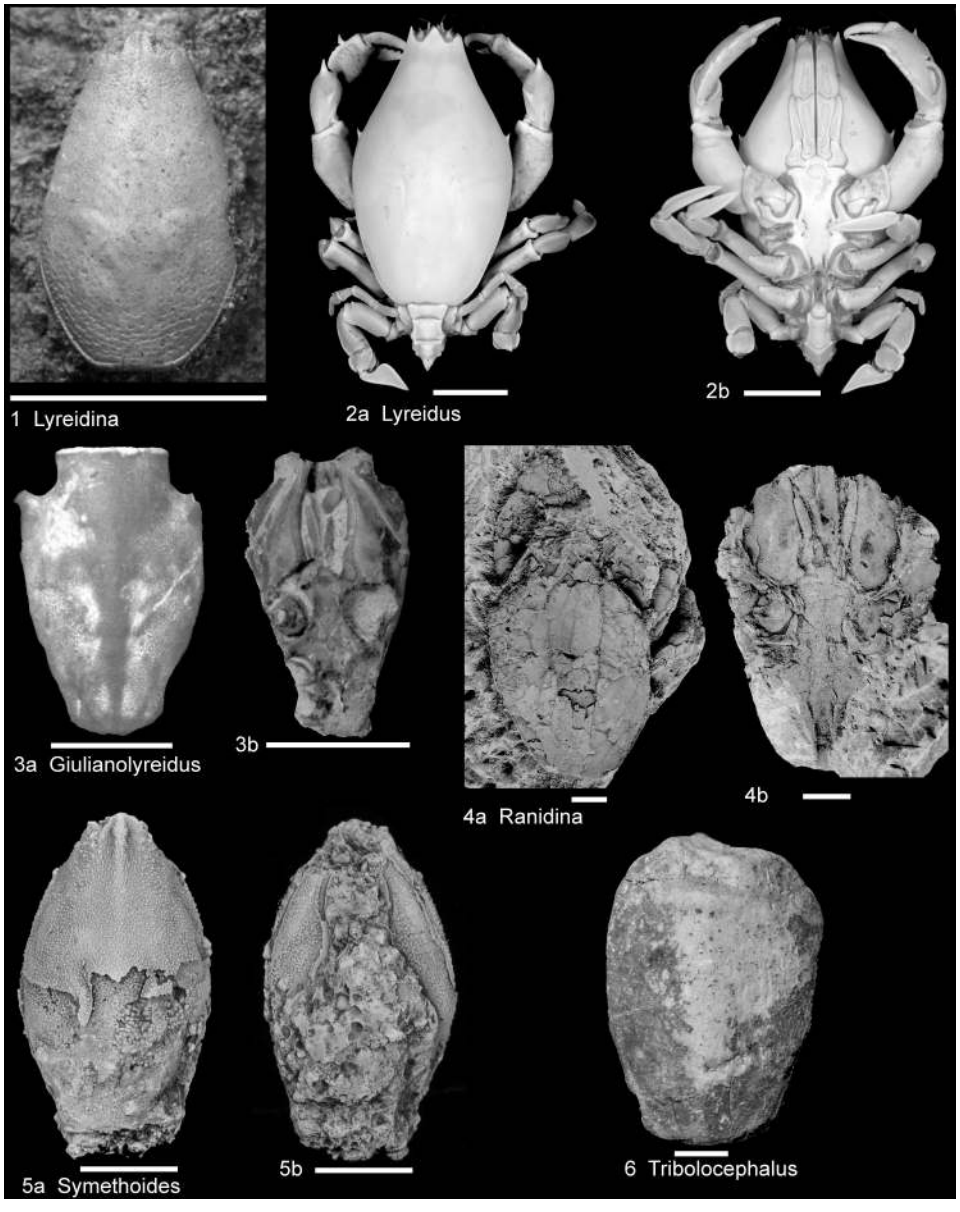


FIG. 10. Lyreididae (p. 18–20).

extensions anteriorly and concave laterally. Sternite 5 of similar shape but smaller, with lyreidid hook (GUINOT, 1979) and double-peg pleonal locking mechanism composed of curved hooks; sternite 6 much smaller, sometimes with ridge; sternites 7 and 8 much reduced in size; pleon narrow in both males and females, telson short, somite 6 long; spermatheca placed on sternite 7, separated by wall; merus of third maxilliped three times longer than ischium. [Emended from KARASAWA & others, 2014, p. 249.] *Upper Cretaceous (Maastrichtian)–Holocene.*

Lyreidus DE HAAN, 1841 in 1833–1850, p. 140, pl. 35,6 [**L. tridentatus;* M] [=*Lysirude* GOEKE, 1985, p. 214 (type, *Raninoides nitidus* A. MILNE-EDWARDS,

1880, p. 34, OD)]. Carapace elongate, very smooth; anterior margin narrow; rostrum trifid, axial spine much larger than outer spines which serve as inner-orbital spines, triangular; outer two spines serving as inner-orbital spines; orbit with one fissure and outer-orbital spine, fronto-orbital width 50 percent or less of maximum carapace width; anterolateral margins with one or no spines. Sternites 1–3 fused, short, crown-shaped; sternite 4 long, with concave lateral margins along which coxa of first pereiopod lies, and triangularly projected anteriorly with short episternal projection posteriorly; sternal suture 4/5 incomplete, curling into a coiled shape; sternite 5 with wide projections anteriorly, flattened axially, and with short episternal projections posteriorly; sternites 6 and 7 narrow, deep axially. Pterygostome in contact with sternite 4. Pleon narrow, sometimes with spines axially on somites, somite 6 very long. [Emended from Karasawa & others, 2014, p. 250.] *Upper Cretaceous (Maastrichtian)–Holocene:* France, *Maastrichtian;* New Zealand, *Eocene (Lutetian–Bartonian);* western Antarctica, Chile, *Eocene;* Caribbean, Hungary *Oligocene;* New Zealand, *Miocene (Aquitanian–Burdigalian);* Italy, *Pliocene (Zanclean)–Pleistocene;* Japan, *Pliocene–Pleistocene;* Tropical Atlantic, Indo-West Pacific, Australia, *Holocene.*——Fig. 10,*2a–b.* **L. tridentatus,* USNM 48278, dorsal (*a*) and ventral (*b*) views, Holocene, Hawaii, scale bars, 1 cm (Feldmann & Schweitzer, 2007, fig. 4C–D).

Giulianolyreidus Karasawa & others, 2014, p. 252 [**Symethis johnsoni* Rathbun, 1935, p. 83, pl. 17,*12–17;* OD]. Maximum carapace width about 35 percent the distance posteriorly, carapace coarsely punctate; fronto-orbital width about 60 percent maximum carapace width; orbits and rostrum poorly known, appearing to have had an intraorbital spine defined by fissures; entire frontal area flared slightly anterolaterally; anterolateral margin short, with one stout anterolateral spine; carapace may have longitudinal keel. Sternites 1–3 fused, short, crown-shaped; sternite 4 long, with concave lateral margins along which coxa of first pereiopod lies, and triangularly projected anteriorly with short episternal projection posteriorly; sternal suture 4/5 incomplete, curling into a coiled shape; sternite 5 with wide projections anteriorly, depressed axially, short episternal projections posteriorly; sternites 6 and 7 narrow, deep axially. Pterygostome in contact with sternite 4. Pleon narrow, somite 6 very long. Coxae indicate pereiopods 1–3 reducing in size posteriorly. [Emended from Karasawa & others, 2014, p. 252.] *Paleocene (Danian–Thanetian):* USA (Texas), *Danian*; USA (Alabama), *Thanetian.*——Fig. 10,*3a–b.* **G. johnsoni* (Rathbun), Thanetian, Alabama; *a*, holotype, USNM 328799, dorsal view; *b*, paratype, USNM 371691, ventral view, scale bars, 1 cm (Karasawa & others, 2014, fig. 12C, D).

Ranidina Bittner, 1893, p. 33, pl. 2,*2* [**R. rosaliae;* M]. Carapace elongate-ovate; rostrum small, triangular, with triangular orbital spine; small, triangular anterolateral spine about one-third the distance posteriorly; carapace axially keeled; sternites 1–3 fused; sternites 4 and 5 narrow; pleon. [Karasawa & others, 2014, p. 252.] *Miocene:* Hungary.——Fig. 10,*4.* **R. rosaliae; a*, lectotype, GBA 1893/004/0001/01, dorsal view; *b*, paralectotype, GBA 1893/004/0001/02, ventral view; scale bars, 5 mm (new; photo courtesy Matúš Hyžný, Comenius University, Bratislava, Slovakia).

Symethoides van Bakel & others, 2012, p. 105, fig. 33 [**S. monmouthorum;* OD]. Carapace fusiform, longer than wide, granular; front narrow; anterolateral and posterolateral margins about equal in length, anterolateral margin appearing to be beaded, posterolateral rimmed; carapace axially keeled anteriorly; strongly vaulted transversely, flattened longitudinally. [Karasawa & others, 2014, p. 253.] *Paleocene (Danian):* USA (New Jersey).——Fig. 10,*5.* **S. monmouthorum,* holotype, AMNH 50421; dorsal (*a*) and ventral (*b*) views, scale bars, 5 mm (new; photo courtesy of B. W. M. van Bakel, Oertijdmuseum De Groene Poort, Boxtel, the Netherlands).

Tribolocephalus Ristori, 1886, p. 127, pl. 2,*19* [**T. laevis;* M]. Carapace longer than wide; rostrum triangular; outer-orbital spines triangular, equal in length to rostrum; carapace with longitudinal keel, granular. [Karasawa & others, 2014, p. 253.] *Pliocene:* Italy.——Fig. 10,*6.* **T. laevis,* holotype, MSN UniFI 2395, scale bar, 5 mm (new; photo courtesy of S. Dominici, Museum of Natural History, University of Florence).

Subfamily BICORNISRANININAE Karasawa & others, 2014

[Bicornisraninae Karasawa & others, 2014, p. 253]

Carapace ovate; rostrum trifid, lateral two spines forming inner-orbital spines, tip singular; intraorbital spines and fissures present; fronto-orbital width ranging from 60 to 85 percent maximum carapace width; one anterolateral spine, which may be bifid; carapace widest at position of anterolateral spine and maintaining that width for anterior quarter of carapace; sternites 1–3 fused, crown shaped; sternite 4 long, with concave lateral margins along which coxa of first pereiopod lies, and with short, anterolaterally directed, spine-like projection anteriorly and short episternal projection posteriorly; sternum and pterygostome articulating; fifth pereiopods with flattened propodi. [Karasawa & others, 2014, p. 253.] *Upper Cretaceous (Santonian).*

Bicornisranina Nyborg & Fam, 2008, p. 687, fig. 5A–H [**B. bocki;* OD]. Carapace ovate; rostrum trifid, lateral two spines forming inner-orbital

spines; intraorbital spine very long, as long as rostrum, bounded by open fissures; outer-orbital spine bifid, outer branch longer than inner; frontoorbital width about 85 percent maximum carapace width; anterolateral spine bifid; carapace widest at position of anterolateral spine and maintaining that width for anterior quarter of carapace; sternites 1-3 fused; sternite 4 long, narrow, with concave lateral margins; fifth pereiopods with flattened propodi. [Karasawa & others, 2014, p. 253.] *Upper Cretaceous (Santonian):* Canada (British Columbia).——Fig. 11,*1a–b*. **B. bocki, a*, GSC 57082, holotype, dorsal view; *b*, CDM 039, ventral view, scale bars, 1 cm (adapted from Nyborg & Fam, 2008, fig. 5A,D).

Subfamily MACROACAENINAE Karasawa & others, 2014

[Macroacaeninae Karasawa & others, 2014, p. 245]

Diagnosis and range as for sole included genus.

Macroacaena Tucker, 1998, p. 325 [**Lyreidus succedanus* Collins & Rasmussen, 1992, p. 23, fig. 11*A–C,* 12; OD] [=*Carinaranina* Tucker, 1998, p. 334 (type, *Eumorphocorystes naselensis* Rathbun, 1926a, p. 100, pl. 24,*9–10;* OD]. Maximum carapace width about 60 percent the distance posteriorly, carapace coarsely punctate; rostrum trifid, fronto-orbital width about half maximum carapace width; orbits with two open fissures, narrow or nearly closed; intraorbital spine defined by fissures and ranging from very short to about half as long as outer-orbital spine; entire frontal area directed forward or flared anterolaterally; anterolateral spine very long and possibly with a small, anterolateral protuberance between it and outer-orbital spine; carapace may have longitudinal keel. Sternites 1–3 fused, crown-shaped; sternite 4 long with concave lateral margins, along which coxa of first pereiopod lies, and with short, anterolaterally directed, spine-like projection anteriorly and short episternal projection posteriorly; sternal suture 4/5 incomplete, curling into a coiled shape; sternite 5 with wide projection anteriorly, depressed axially, short episternal projections posteriorly; sternites 6 and 7 narrow, deep axially. Pterygostome barely in contact with sternite 4 at short anterior projections. Pleon narrow, somite 6 very long. Fifth pereiopod appearing to be reduced in size. [Emended from Karasawa & others, 2014, p. 246.] *Lower Cretaceous (Albian)–Eocene (Priabonian):* Ukraine (Crimea), *Albian;* Germany, *Turonian;* western Greenland, USA (Delaware, New Jersey), *Campanian–Maastrichtian;* Mexico (Coahuila), USA (Alabama), *Selandian;* western Greenland, *Paleocene;* Japan?, *Bartonian;* Canada (British Columbia), USA (Oregon, Washington), Japan, *Priabonian;* USA (Oregon, Washington), *Eocene;* USA (Washington), *Oligocene;* Japan, *Oligocene–Miocene*.——Fig. 11,*2a–b. M. naselensis* (Rathbun), Eocene, Washington, USA; *a*, USNM 493448, dorsal view; *b*, USNM 493446, sternal view, scale bars, 1 cm (Karasawa & others, 2014, fig. 11).

Subfamily MARYLYREIDINAE van Bakel & others, 2012

[Marylyreidinae van Bakel, 2012, p. 85]

Carapace much longer than wide, oblanceolate, widest at about 30 to 50 percent the distance posteriorly; dorsal surface smooth, regions undefined, ornamented with upright nodes or fungiform nodes where cuticle is preserved; fronto-orbital margin wide, ranging from about 66 to 80 percent maximum carapace width; rostrum overall trifid, middle spine ornamented, generally much longer than other two that serve as inner-orbital spines; orbit with intra-orbital and outer-orbital spines; anterolateral margins with one or two spines or entire; sternum-pterygostome junction absent; sternites 1–3 fused, forming a cap-like shape; sternite 4 narrow, with blunt-triangular episternites directed laterally; sternite 5 arcuate, with very large lateral projections, extending as far as lateral margins of carapace; lyreidid hook (Guinot, 1979) and double-peg pleonal locking mechanism composed of short pegs; sternite 6 much smaller, sometimes with ridge; sternites 7 and 8 much reduced in size; pleon narrow in both males and females, telson short, somite 6 long; spermatheca placed on sternite 7, separate. [Emended from Schweitzer & others, 2017, p. 105.] *Lower Cretaceous (Albian)–Upper Cretaceous (Maastrichtian).*

Marylyreidus van Bakel & others, 2012, p. 86 [**Notopocorystes punctatus* Rathbun, 1935, p. 48, pl. 12,*14–16;* OD]. Carapace much longer than wide, oblanceolate, widest at about mid-length; dorsal surface smooth, regions undefined, cuticle composed of fungiform cuticular structures; fronto-orbital margin wide, ranging from about one-half to two-thirds maximum carapace width; rostrum overall trifid, middle spine generally much longer than other two that serve as inner-orbital spines, central spine bifid at tip; orbit with intra- and outer-orbital spines; anterolateral margins with one middle spine; sternum-pterygostome junction absent; third maxilliped apparently articulating with sternite 4; sternites 1–3 fused, forming a cap-like shape; sternite 4 narrow, with

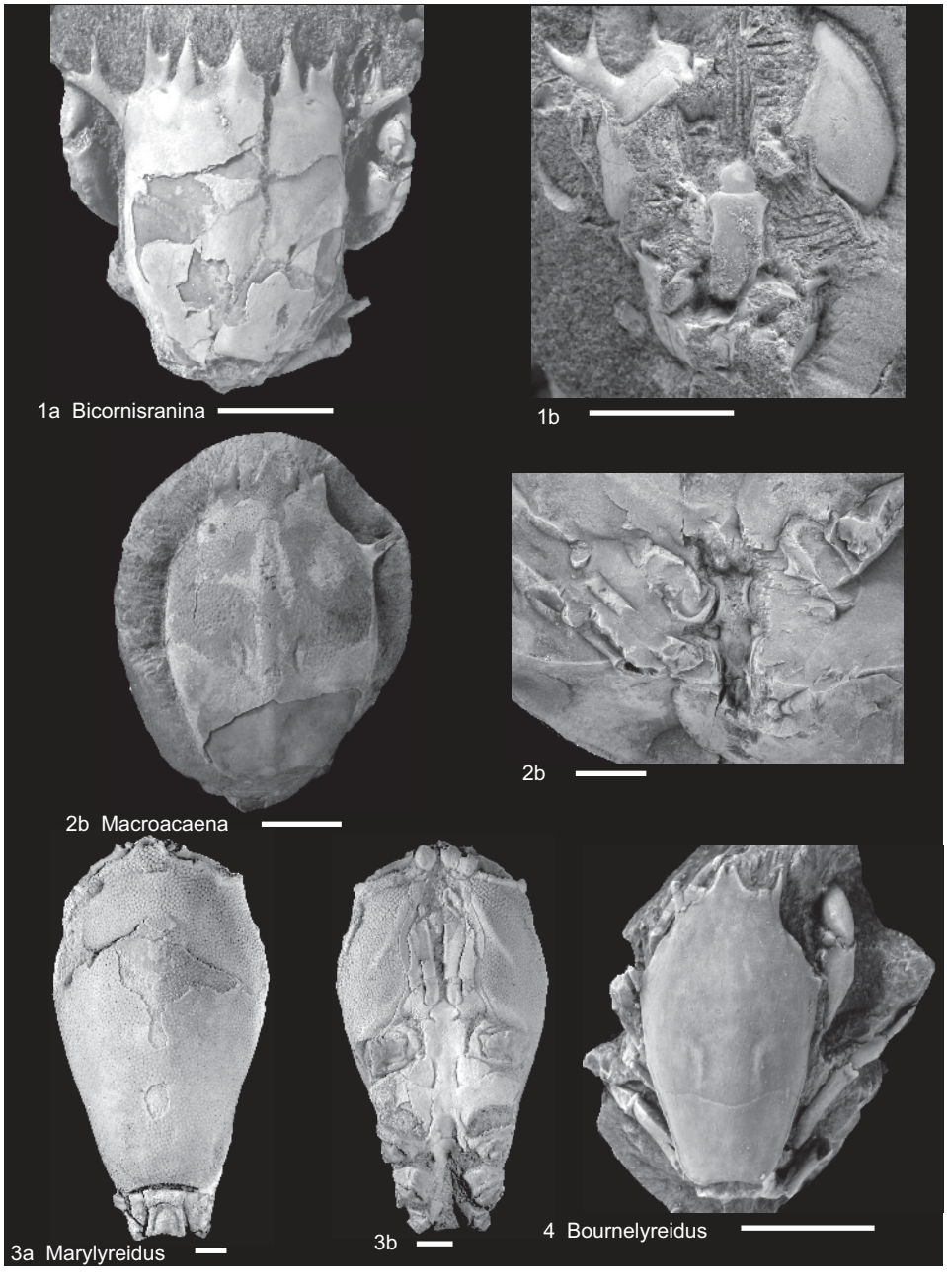


FIG. 11. Lyreididae (p. 20–23).

blunt-triangular episternites directed laterally; sternite 5 with very large lateral projections, arcuate, reaching to lateral edge of dorsal carapace; posterior pereiopod flattened. [Emended from KARASAWA & others, 2014, p. 255.] *Lower Cretaceous (Albian):* USA (Texas).——FIG. 11,*3a–b*. **M. punctatus* (RATHBUN), USNM 559038, dorsal (*a*) and ventral (*b*) views, scale bars, 1 cm (Karasawa & others, 2014, fig. 14A–B).

Bournelyreidus VAN BAKEL & others, 2012, p. 78 [**Hemioon eysunesensis* COLLINS & RASMUSSEN, 1992, p. 19, fig. 10; OD]. Carapace much longer than wide, oblanceolate, widest at about mid-length; fronto-orbital margin wide, ranging about



FIG. 12. Lyreididae (p. 23–24).

one-half to two-thirds maximum carapace width; rostrum overall trifid, middle spine generally much longer than other two that serve as inner-orbital spines, middle spine bifid at tip; orbit with intra- and outer-orbital spines; anterolateral margins with two spines; sternum-pterygostome junction absent; sternite 4 articulating with third maxilliped; sternites 1–3 fused, forming a cap-like shape; sternite 4 narrow, with short, arcuate projections anteriorly, concave laterally, and blunt-triangular episternites directed laterally; sternite 5 with moderate, arcuate lateral projections; chelae flattened, lower margin with spines. [Emended from KARASAWA & others, 2014, p. 254.] *Upper Cretaceous (Turonian–Maastrictian):* Germany, USA (Kansas), *Turonian;* western Greenland, *Campanian;* USA (North Dakota, South Dakota), *Campanian–Maastrichtian;* Mexico (Coahuila), *Maastrichtian.*——FIG. 11,*4*. **B. eysunesensis* (COLLINS & RASMUSSEN), cast of paratype, MGUH 21593, numbered KSU D 2234, Campanian, Greenland, scale bar, 1 cm (Karasawa & others, 2014, fig. 14C).

Delyrius SCHWEITZER & others, 2017, p. 106, fig. 8 [**D. carthagensis;* OD]. Carapace ovate; fronto-orbital width 66 to 75 percent maximum carapace width; rostrum with trifid central spine; intraorbital spines undeveloped; anterolateral margins entire; carapace widest about 30 percent of the distance posteriorly. [SCHWEITZER & others, 2017, p. 106.] *Upper Cretaceous (Turonian):* USA (New Mexico).——FIG. 12,*1*. **D. carthagensis,* holotype, USNM 640024, dorsal view, scale bars, 1 cm (Schweitzer & others, 2017, fig. 8,*1*).

Hemioon BELL, 1863, p. 10, pl. 2,*4–7* [**H. cunningtonii*; M]. Carapace generally smooth on interior molds, appears to lack anterolateral ornamentation, may have an axial keel; some swellings on carapace mark position of cervical and branchiocardiac grooves on molds of the interior; cuticle ornamented with strap-like ornamentation and nodes; widest about one-third the distance posteriorly;

fronto-orbital width about half maximum carapace width; sternites 1–3 fused, cap-shaped; sternite 4 long, with short projections anteriorly, concave laterally, appearing to have short projections posteriorly; sternal suture 4/5 incomplete; sternum appears to be separated from pterygostome by third maxilliped. [Emended from Karasawa & others, 2014, p. 254.] *Lower Cretaceous (Albian)–Upper Cretaceous (Maastrichtian):* New Zealand, UK (England), *Albian;* Czech Republic, Germany, *Coniacian–Maastrichtian.*——Fig. 12,*2a–b*. **H. cunningtonii,* syntype, SM B 23289, Albian, England; *a*, dorsal view with bopyrid swelling in left branchial chamber; *b*, ventral view, scale bars, 1 cm (Karasawa & others, 2014, fig. 14D–E).

Heus Bishop & Williams, 2000, p. 290, fig. 4 [**H. foersteri;* OD]. Carapace obovate, width about 68 percent of length; widest about one-third the distance posteriorly; frontal margin narrow; rostrum triangular, sulcate, with axial keel; orbits with an open fissure and broad outer-orbital spine, frontoorbital width about 58 percent maximum carapace width; small spine about one-third the distance posteriorly on anterolateral margin; dorsal surface with weak, oblong swelling on protogastric region on mold of interior. [Emended from Karasawa & others, 2014, p. 255.] *Upper Cretaceous (Campanian–Maastrichtian):* USA (Colorado, South Dakota).——Fig. 12,*3*. **H. foersteri,* holotype, SDSMT 11016, dorsal carapace, Campanian–Maastrichtian, South Dakota, scale bar, 1 cm (new).

Subfamily ROGUEINAE Karasawa & others, 2014

[Subfamily Rogueinae Karasawa & others, 2014, p. 244]

Diagnosis and range as for sole included genus.

Rogueus Berglund & Feldmann, 1989, p. 70, fig. 2–3 [**R. orri;* OD]. Carapace much longer than wide, oblanceolate; dorsal surface smooth or punctate, regions undefined; anterior margin wide, about 75 percent maximum carapace width; rostrum overall trifid, middle spine generally much longer than other two that serve as inner-orbital spines, inner spine itself bifid at tip; orbital margin sinuous, intraorbital spine absent; supraorbital spine absent; anterolateral margins with one bifid spine; sternum-pterygostome junction apparently present; sternites 1–3 fused, forming a cap-like shape; sternite 4 large, with short lateral extensions anteriorly, concave laterally, sternal suture 4/5 incomplete, curling into a coiled shape; sternite 5 with wide lateral extensions anteriorly; sternite 6 much smaller, with ridge laterally; chela flattened, with spines on lower margin. [Emended from Karasawa & others, 2014, p. 244.] *Paleocene (Selandian)–Eocene (Lutetian):* Denmark, *Selandian;* USA (Oregon), *Lutetian.*——Fig. 12,*4a–b*. **R. orri,* Lutetian, Oregon; *a*, holotype, USNM 430027, dorsal carapace; *b*, paratype USNM 430038, scale bars, 1 cm (Karasawa & others, 2014, fig. 10).

Family RANINIDAE de Haan, 1839 in 1833–1850

[*nom. correct.* White, 1847, p. 56, *pro* Raninoidea de Haan, 1839 in 1833–1850, p. 102] [=Notopterygia Latreille, 1831, p. 368; Raninellidae Beurlen, 1930, p. 363; Cosmonotini Števčić, 2005, p. 27]

Carapace longer than wide, generally ovate, usually vaulted transversely; usually with rostrum and orbital spines; anterolateral margin generally with 1 to 3 spines; posterolateral margin long, usually entire; carapace regions generally undifferentiated; branchiocardiac groove developed as boundary of urogastric region; gymnopleuran condition present; sternum narrow; sternites 1–3 generally fused; sternites 4 and 5 flattened; sternite 6 raised; sternites 7 and 8 often reduced and at lower level than other sternites; sternite 7 extremely narrow, sternal suture 5/6 complete; pleon narrow in males and females, showing reduced but clear dimorphism; sterno-pleonal depression absent; pleonal locking mechanism absent, pleon unfolded and often extending posteriorly from carapace, pleonal somite 6 as long as somite 5; genital openings coxal, spermatheca present; basis of third maxilliped fused to ischium; chelipeds usually with distinct chelae with finger oriented at nearly right angles to manus; fifth pereiopod may be modified for burrowing. [Emended from Karasawa & others, 2014, p. 256.] *Lower Cretaceous (Albian)–Holocene.*

Sabahranina Collins, Lee, & Noad, 2003, p. 200, pl. 1,*3* [**S. trushidupensis;* OD]. Carapace longer than wide, posterior margin appearing to be squared; rostrum trifid; orbit with one intraorbital spine, one short fissure, and large outer-orbital spine; one small anterolateral spine; orbital spines and rostrum directed upward; carapace deeply pitted overall, except the frontal margin. *Miocene (Burdigalian?):* Malaysia (Sabah, northern Borneo).——Fig. 12, *1*. **S. trushidupensis,* holotype, BMNH IC 162, scale bar, 1 cm (new).

Subfamily CYRTORHININAE Guinot, 1993

[*nom. correct.* Tucker, 1998, p. 322, *pro* Cyrthorhinae Guinot, 1993, p. 1330]

Carapace ovate, longer than wide, bulbous, widest at about mid-length; rostrum trifid,

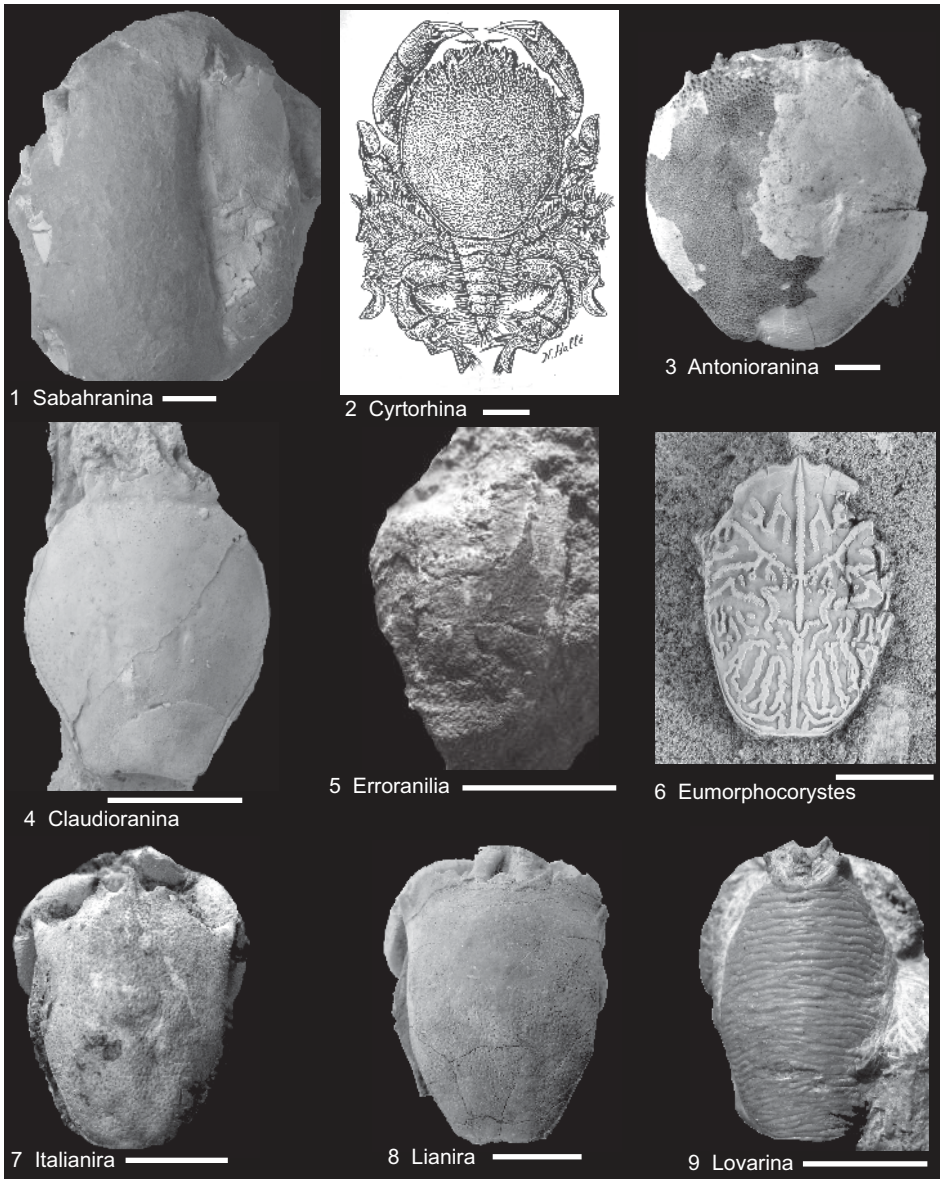


FIG. 12. Raninidae (p. 24–27).

central spine longest, outer two spines also forming inner-orbital spines; orbits with intra- and outer-orbital spines; entire frontal area including rostrum and orbits set at lower level than remainder of carapace, fronto-orbital width about half maximum carapace width; anterolateral margin with at least two spines, excluding outer-orbital spine; carapace surface granular in post-frontal region, remainder relatively smooth; junction between pterygostome and sternum narrow; sternites 1–3 fused, small; sternites 3 and 4 narrow; sternite 4 long, with two grooves parallel to lateral margins, flattened; sternite 5 wider than 4, raised, with axial groove; sternite 6 diamond shaped, with axial groove,

sternum very narrow between sternites 5 and 6; sternites 7 and 8 reduced; male pleon triangular; coxa of pereiopod 5 large. [Emended from KARASAWA & others, 2014, p. 259.] *Eocene (Ypresian)–Holocene.*

Cyrtorhina MONOD, 1956, p. 49, fig. 19–31 [**C. granulosa;* M]. Carapace ovate, approaching circular in shape; anterolateral margin with multiple spines and granules; anterior areas of carapace granular; chelae may have long spines on fixed finger and upper margin of propodus; sternites 1–3 fused, T-shaped; sternite 4 narrow, with arcuate lateral grooves; sternite 5 wide anteriorly, with rounded lateral margins, narrowing posteriorly; sternite 6 short, wide. [KARASAWA & others, 2014, p. 259.] *Holocene:* Africa (Ghana), Philippines.——FIG. 12,*2. *C. granulosa,* Holocene, Ghana, scale bar, 1 cm (Monod, 1956, fig. 19).

Antonioranina VAN BAKEL & others, 2012, p. 108 [**Cyrtorhina globosa* BESHIN & others, 1988, p. 163, pl. 2,*3;* OD]. Carapace ovate, approaching circular in shape; fronto-orbital margins continuous with anterolateral margins; anterolateral margins with two or three spines; anterior portion of carapace may be granular; chelae appearing to lack long spines; sternites 1–3 fused, flattened; sternite 4 with straight lateral grooves; sternite 5 moderately wide anteriorly, with straight to slightly concave lateral margins, narrowing posteriorly; sternite 6 moderately long, wide, with triangular lateral extensions. [KARASAWA & others, 2014, p. 259.] *Eocene (Ypresian–Priabonian):* Spain, *Ypresian;* Croatia, Italy, USA (South Carolina), *Ypresian–Bartonian;* USA (North Carolina), *Priabonian.*——FIG. 12,*3. A. fusseli* (BLOW & MANNING, 1996), PI 18558, Bartonian, South Carolina, scale bar, 1 cm (new; photo provided by A. Franţescu, University of Pittsburgh, Bradford, Pennsylvania).

Claudioranina KARASAWA & others, 2014, p. 259 [**Cyrtorhina oblonga* BESCHIN & others, 1988, p. 166, pl. 3,*1–3;* OD]. Carapace oblong, anteriorly and posteriorly narrowed; frontal margin set distinctly below level of remainder of carapace, fronto-orbital margin not grading smoothly into anterolateral margin, forming about 120° angle between outer-orbital spine and anterolateral margin; anterolateral margin with two spines; posterolateral margin sinuous, centrally concave; sternite 3 wide; sternite 4 wide, with arcuate lateral grooves; sternite 5 moderately widened anteriorly, with a slight projection anteriorly that articulates with or slightly overlaps posterior margin of sternite 4 and with straight to lateral margins, narrowing posteriorly; sternite 6 moderately long and wide, with straight lateral margins. [Emended from KARASAWA & others, 2014, p. 259.] *Paleocene (Selandian)–Eocene (Bartonian):* Mexico (Coahuila), *Selandian;* Italy, *Lutetian–Bartonian.*——FIG. 12,*4. *C. oblonga* (BESCHIN & others), cast of holotype MCZ 1100, KSU D 14, Lutetian–Bartonian, Italy, scale bar, 1 cm (Karasawa & others, 2014, fig. 17).

Subfamily NOTOPODINAE Serène & Umali, 1972

[*nom. correct.* GOEKE, 1985, p. 224, *pro* Notopinae SERÈNE & UMALI, 1972, p. 29]

Carapace wide for family, strongly vaulted transversely; often with deep reentrant at position of antennae interpreted to be in axis of rostrum, usually without outer-orbital fissures (except *Umalia*); rostrum bifid or trifid; post-frontal region often ornamented; anterolateral margins with one spine; often with a straight segment which could be interpreted as a lateral margin so that carapace is essentially octagonal; sternites 1–3 fused, cap-like; sternite 4 wide, with short anterolateral projections, concave laterally; posterior portion of sternite 5 and sternites 6, 7, and 8 very narrow; sternite 5 with broad anterior projections; sternite 6 flattened; sternite 8 very reduced; spermathecae very closely situated so that they are almost united; ischium of third maxilliped with oblique crest; notopodine-type chelae present (chela very high, with very reduced fixed finger and long, movable finger, large gape between two fingers). [KARASAWA & others, 2014, p. 261.] *Upper Cretaceous (Maastrichtian)–Holocene.*

Erroranilia BOYKO, 2004, p. 931, *nom. nov. pro Paralbunea* HU & TAO, 1996, p. 62, *non Paralbunea* SERÈNE, 1977, p. 54 (crustacean) [**Paralbunea taipeiensis* HU & TAO, 1996, p. 62; M]. Carapace longer than wide, widest anteriorly. Specimen very poorly preserved. *Miocene (Aquitanian–Burdigalian):* Taiwan.——FIG. 12,*5. **E. taipeiensis* (HU & TAO), holotype, NMNS 007607, scale bar, 1 cm (new; photo by T.-Y. Chan, National Taiwan Ocean University).

Eumorphocorystes VAN BINKHORST, 1857, p. 108, pl. 6,*1–2* [**E. sculptus;* M]**.** Carapace elongate, widest in anterior one-fifth at position of anterolateral margin; front trifid, central spine much longer than lateral spines; orbits with two fissures, intraorbital and outer-orbital spines; fronto-orbital width about 64 percent of maximum carapace width; long spine at anterior corner; carapace surface with distinctive strap-like ornamentation over entire surface and longitudinal, axial keel. [Emended from KARASAWA & others, 2014, p. 263.] *Upper Cretaceous (Maastrichtian):* Belgium, The Netherlands.——FIG. 12,*6. **E. sculptus,* KSU D 443, cast of NHMM 1993 097, Maastrichtian,The Netherlands, scale bar, 1 cm (new).

Italianira KARASAWA & others, 2014, p. 263 [**Ranilia punctulata* BESCHIN & others, 1988, p. 196, pl. 11,*1–2;* OD]. Carapace elongate, widest in ante-

rior one-fifth of carapace at position of anterolateral spine; rostrum trifid, middle spine singular, lateral two spines serving as inner-orbital spines; remainder of anterior margin arcuate, sinuous, merging smoothly into anterolateral spine; lateral and posterolateral margins confluent, weakly convex; carapace punctate; sternites 1–3 fused, cap-like; sternite 4 wide, with long antero-lateral projections, concave laterally; sternite 5 wide; notopodine-type chelae present (chela very high, with very reduced fixed finger and long movable finger, large gape between two fingers), proximal elements of chelipeds with transverse ridges. [Emended from Karasawa & others, 2014, p. 263.] *Eocene (Ypresian–Lutetian):* Italy.——Fig. 12,*7*. **I. punctulata* (Beschin & others), holotype, MCZ (VI) 1120, scale bar, 1 cm (new, photo by A. De Angeli, Associazione Amici del Museo Zannato, Montecchio Maggiore, Vicenza, Italy).

Lianira Beschin & others, 1991, p. 195, pl. 1–3 [**L. beschini;* OD]. Carapace oblong, flared anteriorly, widest along anterior margin of carapace; frontal margin very wide; rostrum sharp, triangular, and well developed; long, triangular inner-orbital spine, remainder of orbital margin a long, flared, spinose projection; lateral spine just distal to outer-orbital angle, stout; lateral margins parallel, then converging posteriorly; surface punctate; sternites 1–3 fused, cap-like; sternite 4 wide, with wide antero-lateral projections, concave laterally; chelipeds with transverse setal pores or ridges. [Emended from Karasawa & others, 2014, p. 263.] *Eocene (Ypresian–Lutetian):* Italy.——Fig. 12,*8*. **L. beschini,* paratype, MCZ1232, Ypresian–Lutetian, Italy, scale bar, 1 cm (new, photo by A. De Angeli, Associazione Amici del Museo Zannato, Montecchio Maggiore Vicenza, Italy).

Lovarina Beschin & others, 1991, p. 201, pl. 5 [**L. cristata;* OD]. Carapace ovate, much longer than wide, apparently widest in anterior one-quarter; strongly vaulted transversely; frontal margin strongly concave at position of antennae, rimmed; apparently outer-orbital spines; no anterolateral spines apparent; carapace and chelae ornamented by transverse, closely spaced, subparallel ridges. [Karasawa & others, 2014, p. 264.] *Eocene (Lutetian):* Italy.——Fig. 12,9. **L. cristata,* holotype, MCZ 1224, scale bar, 1 cm (new, photo by A. De Angeli, Associazione Amici del Museo Zannato, Montecchio Maggiore, Vicenza, Italy).

Notopella Lőrenthey in Lőrenthey & Beurlen, 1929, p. 119, pl. 5,*7* [**N. vareolata;* M]. Carapace elongate-trapezoidal, widest in anterior one-fifth, at position of anterolateral spines; rostrum triangular; orbital margins apparently with two spines; fronto-orbital width about 65 percent of maximum carapace width; anterolateral margins very short; lateral margins converging posteriorly, nearly straight; carapace axially keeled. [Emended from Karasawa & others, 2014, p. 262.] *Eocene (Priabonian):* Hungary.——Fig. 13,*1*. **N. variolata,* syntype, MAFI Lőrenthey Collection 37, scale bar, 1 cm (Karasawa & others, 2014, fig. 19B).

Notoporanina Lőrenthey in Lőrenthey & Beurlen, 1929, p. 116 [*Notopus beyrichi* Bittner, 1875, p, 72, pl. 1,*6;* M]. Carapace ovate, widest in anterior one-quarter; rostrum trifid, central spine singular and with double groove axially; outer two spines serving as inner-orbital spines; intraorbital spine bounded by closed fissures; outer-orbital spine short, directed axially; fronto-orbital width about 77 percent of maximum carapace width; anterolateral spine very short, forward directed; post-frontal ridge discontinuous, interrupted axially; lateral margins and posterolateral margins confluent, arcuate, rimmed; sternites 1–3 fused, cap-like; sternite 4 wide, with short antero-lateral projections, concave laterally; chelipeds with transverse ridges, large granules on upper margin of manus of chela. [Emended from Karasawa & others, 2014, p. 263.] *Eocene (Lutetian)–Miocene:* Hungary, Italy, *Lutetian;* Hungary, *Miocene*.——Fig. 13,*2*. **N. beyrichi* (Bittner), KSU D 1590, cast of specimen from Miocene, Hungary, scale bar, 1 cm (Karasawa & others, 2014, fig. 19D).

Notopus de Haan, 1841 in 1833–1850, p. 139 [**Cancer dorsipes* Linnaeus, 1758, p. 630; M]. Carapace widest anteriorly, with weak longitudinal keel; rostrum triangular; orbits with triangular inner-orbital spine, outer-orbital spine, and serrate margin between the spines; fronto-orbital width about 65 percent of maximum carapace width; long spine placed at anterolateral corner; post-frontal ridge well developed, may be serrate; lateral margins parallel, may be weakly serrate; posterolateral margins converging; sternites 1–3 fused, cap-like; sternite 4 wide, concave laterally, with short anterolateral projections, concave laterally; sternite 5, posterior portion, and sternites 6–8 very narrow; sternite 5 with broad anterior projections; sternite 6 flattened; sternite 8 reduced; spermatheca very closely situated so that they are almost united; ischium of third maxilliped with oblique crest; chela very high, with very reduced fixed finger and long movable finger, large gape between two fingers. [Emended from Karasawa & others, 2014, p. 262.] *Eocene (Lutetian–Bartonian)–Holocene:* Mexico (Chiapas), *Lutetian–Bartonian;* Indo-Pacific, Mediterranean, *Holocene.*——Fig. 13,*3*. **N. dorsipes* (Linnaeus), Holocene, Japan, specimen from Senckenberg Forschungsinstitut und Naturmuseum, Frankfurt, scale bar, 1 cm (new).

Ponotus Karasawa & Ohara, 2009, p. 200, fig. 1 [**P. shirahamensis;* OD]. Carapace long, widest just posterior to anterolateral spine; rostrum broadly triangular; orbits with small, triangular inner-orbital spine, followed by short fissure, followed by broad segment and small outer-orbital spine; fronto-orbital width about 70 percent of maximum carapace width; small anterolateral spine; carapace axially keeled with large pores; post-frontal ridge absent; lateral margin with short, transeverse terraces; sternites 1–3 fused, cap-like; sternite 4 wide with short antero-lateral projections and concave laterally; posterior portion of sternite 5 narrow; chela very high, with very reduced fixed

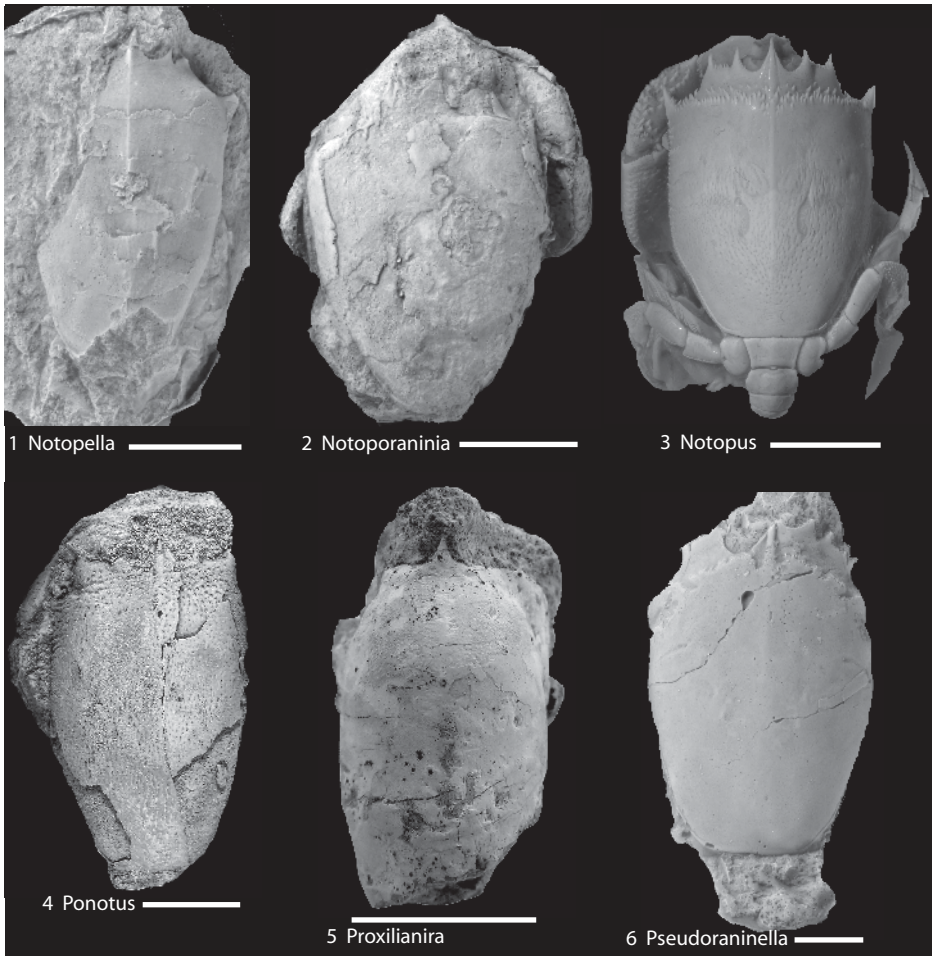


FIG. 13. Raninidae (p. 27–28).

finger and long, movable finger, large gape between two fingers. [Emended from KARASAWA & others, 2014, p. 262.] *Miocene (Langhian):* Japan.——FIG. 13,*4*. **P. shirahamensis,* paratype, MFM 83067, scale bar, 1 cm (new).

Proxilianira DE ANGELI & CECCON, 2017, p. 34, fig. 3–4 [**P. albertii;* OD]. Carapace much longer than wide, widest at frontal margin; strongly vaulted transversely; very strong post-frontal ridge; frontal and anterolateral margin developed as a strong, depressed rim; rostrum triangular, apparently one small orbital notch; very small anterolateral spine at corner of frontal and anterolateral margins, spine nearly fused with anterolateral margin; posterior margin converging strongly posteriorly into rounded tip. *Eocene (Priabonian):* Italy.——FIG. 13,*5*. **P. albertii,* paratype MCV 16/02-I. G. 370029, scale bar, 1 cm (De Angeli & Ceccon, 2017, fig. 4,*2A*).

Pseudoraninella BEURLEN in LŐRENTHEY & BEURLEN, 1929, p. 298 [**Notopocorystes mulleri* VAN BINKHORST, 1857, p. 107; SD GLAESSNER, 1969, p. 500]. Carapace with tubercles anteriorly, posterior to tubercles a well-defined, scabrous post-frontal ridge; rostrum long, needlelike, extending onto carapace as clear axial ridge; orbits with sharp inner, intra-, and outer-orbital spines, margins serrate between spines; fronto-orbital width 78 percent of maximum width; long, slender anterolateral spine positioned a short distance posteriorly on margin; lateral and posterolateral margins confluent, converging posteriorly. [Emended from KARASAWA & others, 2014, p. 263.] *Upper Cretaceous (Maastrichtian)–Eocene (Priabonian):* The Netherlands, *Maastrichtian;* Germany, *Eocene (Priabonian).*——FIG. 13,*6*. **P. mulleri* (VAN BINKHORST), KSU D 86, cast of holotype MBA 238, Maastrichtian, The Netherlands, scale bar, 1 cm (Karasawa & others, 2014, fig. 19A).

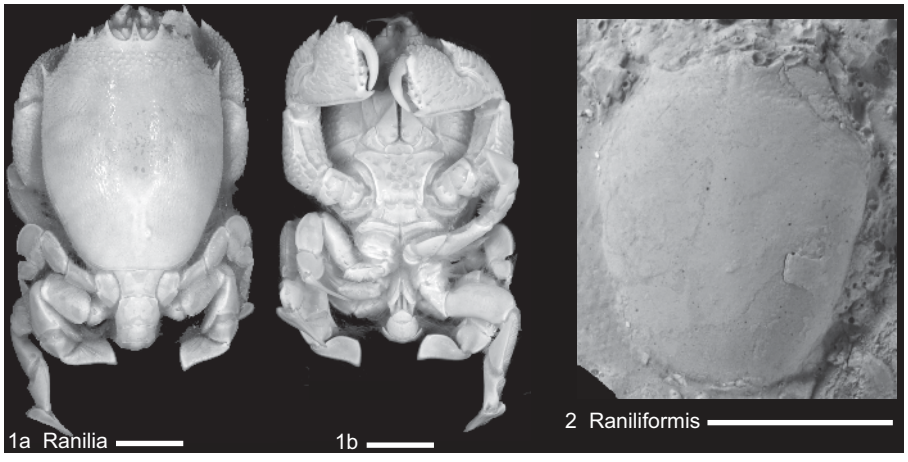


FIG. 14. Raninidae (p. 28).

Ranilia H. MILNE EDWARDS, 1837 in 1834–1840, p. 195 [**R. muricata;* M]. Carapace ovate; rostrum sharp, needlelike, with concave frontal margins on both sides; upper orbital margin oblique; triangular inner-orbital spines followed by smaller, triangular intra- and outer-orbital spines, outer margins of spines serrate; small, needlelike anterolateral spine placed about one-quarter of distance posteriorly, anterolateral margin weakly serrate; post-frontal region scabrous; lateral margins parallel, very weakly serrate anteriorly; posterolateral margin weakly concave, sinuous; sternites 1–3 fused, cap-like; sternite 4 wide, with short anterolateral projections, tufts of short setae, and concave laterally; posterior portion of sternite 5 narrow; notopodine-type chelae present (chela very high, with very reduced fixed finger and long movable finger, large gape between two fingers), ornamented with tufts of short setae. [Emended from KARASAWA & others, 2014, p. 262.] *Pliocene–Holocene:* Curaçao, *Pliocene;* Italy, *Pleistocene;* Tropical Atlantic and Indo-West Pacific, eastern tropical Pacific, *Holocene.*——FIG. 14,*1a–b*. **R. muricata,* USNM 267897, Holocene, Florida; dorsal (*a*) and ventral (*b*) views, scale bar, 1 cm (new).

Raniliformis JAGT, COLLINS, & FRAAYE, 1993, p. 178 [**Raninella baltica* SEGERBERG, 1900, p. 22, pl. 2,*9–11;* OD]. Carapace ovate, very strongly vaulted transversely, triangular in cross section, flattened longitudinally; carapace widest in anterior one-third; rostrum triangular, axially keeled; orbit with triangular inner-orbital spine, followed by fissure; broad intraorbital projection, highest axially, followed by short fissure; followed by long, straight segment, followed by long outer-orbital projection; all orbital margins serrate; fronto-orbital width about 60 percent of maximum carapace width; stout, long anterolateral spine directed anterolaterally; post-frontal region with short, scabrous ridges, remainder of carapace punctate. [Emended from KARASAWA & others, 2014, p. 264.] *Upper Cretaceous (Maastrichtian)–Eocene (Lutetian):* The Netherlands, *Maastrichtian;* Denmark, The Netherlands, *Paleocene (Danian);* Italy, *Eocene (Lutetian).*——FIG. 14,*2*. **R. baltica* (SEGERBERG), KSU D 1731, cast of JSHC 1981, Danian, Denmark, scale bar, 1 cm (new).

Rugosanilia BESCHIN, DE ANGELI, & others, 2016, p. 34 [**Raniliformis rugosa* DE ANGELI & BESCHIN, 2007, p. 35, pl. 2,*1a–b,2;* OD]. Carapace longer than wide, widest at anterolateral corner about 25 percent of the distance posteriorly; post-frontal ridge present; strongly vaulted transversely; rostrum triangular, axially keeled; inner-orbital spine short, followed by notch, closed fissure near lateral edge of orbital margin; anterolateral margin shorter than posterolateral, with one spine; carapace surface ornamented with evenly spaced granules anteriorly and longitudinal rugae over posterior two-thirds. *Eocene (Lutetian):* Italy.——FIG. 15,*1*. **R. rugosa* (DE ANGELI & BESCHIN), holotype, MCZ 2684, scale bar, 1 cm (Beschin, De Angeli, & others, 2016, pl. 5,*1*).

Umalia GUINOT, 1993, p. 1330 [**Notopus misakiensis* SAKAI, 1937, p. 176, fig. 4; OD]. Carapace widest near front; lateral margins parallel, straight, converging posteriorly; rostrum triangular, frontal margin concave on either side of rostrum, concavities followed by nearly straight segment with two fissures, frontal margin then sloping obliquely to base of short anterolateral spine; carapace surface ornamented with small tubercles; pereiopod 5 much reduced, subdorsal. [KARASAWA & others, 2014, p. 261.] *Eocene (Lutetian)–Holocene:* Italy, *Lutetian;* Japan, *Miocene;* Japan, *Pleistocene;* Australia, Indo-West Pacific, *Holocene.*——FIG. 15,*2*. *U. orientalis* (SAKAI, 1963), Senckenberg Forschungsinstitut und Naturmuseum, Frankfurt, Holocene, western Pacific, scale bar, 1 cm (new).

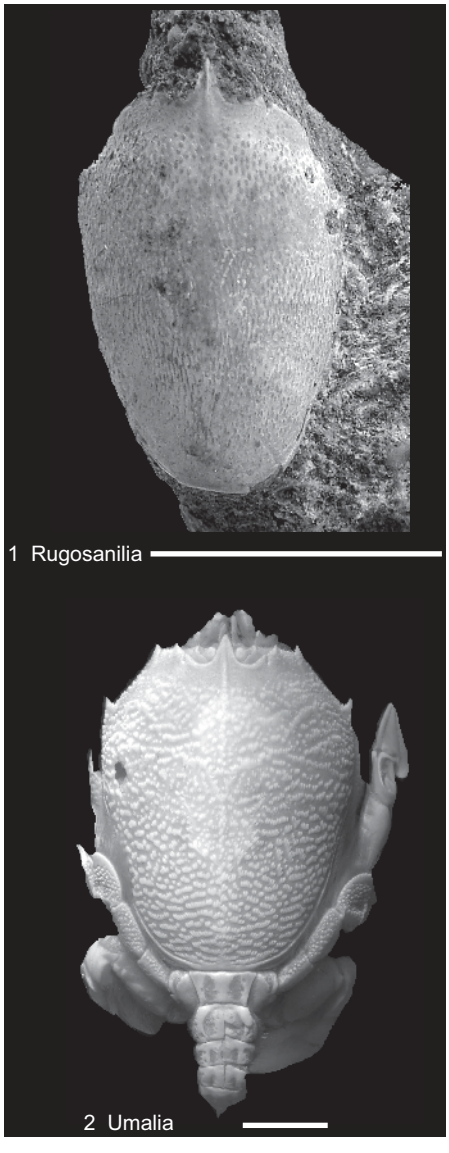


Fig. 15. Raninidae (p. 29).

Subfamily RANININAE de Haan, 1839 in 1833–1850

[*nom. transl.* Serène & Umali, 1972, p. 34, *pro* Raninoidea de Haan, 1839 in 1833–1850, p. 136]

Carapace ovate, wide; orbits well ornamented with many spines that may be complex, outer-orbital spine well developed; usually two anterolateral spines that may be complex and may exhibit sexual dimorphism (see Feldmann & Schweitzer, 2007, for example); dorsal surface scabrous or terraced; sternites 1–4 forming a distinctive, trifid form anteriorly and with concave sides laterally; sternite 5 coming to a V-shape posteriorly; sternites 5–8 very reduced; spermathecae very closely spaced; pleon sexually dimorphic, somites 1 and 2 equal in width in males, somite 2 wider than 1 in females. [Emended from Karasawa & others, 2014, p. 259.] *Upper Cretaceous (Cenomanian)–Holocene.*

Ranina Lamarck, 1801, p. 156 [**Cancer raninus* Linnaeus, 1758, p. 625; M; =*Ranina serrata* Lamarck, 1801, p. 156, obj.] [=*Hela* Münster, 1840, p. 24, pl. 2,*1–3;* (type, *H. speciosa,* SD Glaessner, 1969, p. 498); =*Etoranina* Fabiani, 1910, p. 88 (type, *Ranina dentata* Latreille, 1825, p. 268, OD)]. Carapace generally widest in anterior one-quarter, narrowing posteriorly; rostrum trifid, with lateral two spines serving as inner-orbital spines, central spine triangular; intra- and outer-orbital spines triangular; anterolateral margin generally with two spines that are bifid or trifid, often larger and more complexly ornamented in larger males; postfrontal region depressed slightly below level of remainder of carapace, can be granular or scabrous; remainder of carapace ornamented with forward-directed spines; appendages and pterygstome ornamented with less densely spaced spines; sternum smooth. [Emended from Karasawa & others 2014, p. 260.] *Upper Cretaceous (Maastrichtian)–Holocene:* India, *Maastrichtian;* Libya *Paleocene (Danian);* USA (North Dakota), ?*Paleocene;* Germany, *Eocene (Lutetian–Bartonian);* Italy, *Eocene (Lutetian–Priabonian);* USA (Washington), *Eocene (Priabonian)–Oligocene (Chattian);* France; USA (California), *Eocene;* France, Germany, Hungary, Italy, Slovakia, *Oligocene;* Algeria, Indonesia (Borneo), Fiji, Italy, *Miocene;* Italy, *Pliocene;* Italy, Japan, *Pleistocene;* Australia, Indo-Pacific, *Holocene.*——Fig. 16*a–d*. **R. ranina* (Linnaeus), female, USNM 2044, Holocene, Hawaii, USA, dorsal (*a*) and ventral (*b*) views; *c–d*, male, USNM 268506, Holocene, Philippines, dorsal (*c*) and ventral (*d*) views, scale bars, 1 cm (new).

Alcespina Pasini & Garassino, 2017, p. 88, fig. 2–7 [**A. ovadaensis;* OD]. Carapace ovate, widest about half the distance posteriorly, well posterior to anterolateral spines**,** and narrowing posteriorly; rostrum trifid, with lateral two spines serving as inner-orbital spines, central spine triangular; intra- and outer-orbital spines long; anterolateral margin with two spines, the anteriormost shorter, bifid and second spine long, directed laterally, and ornamented with 4 spinelets; anterolateral spines often larger and more complexly ornamented in males; carapace granular or with longitudinally elongate tubercles; chelae with transverse ridges.

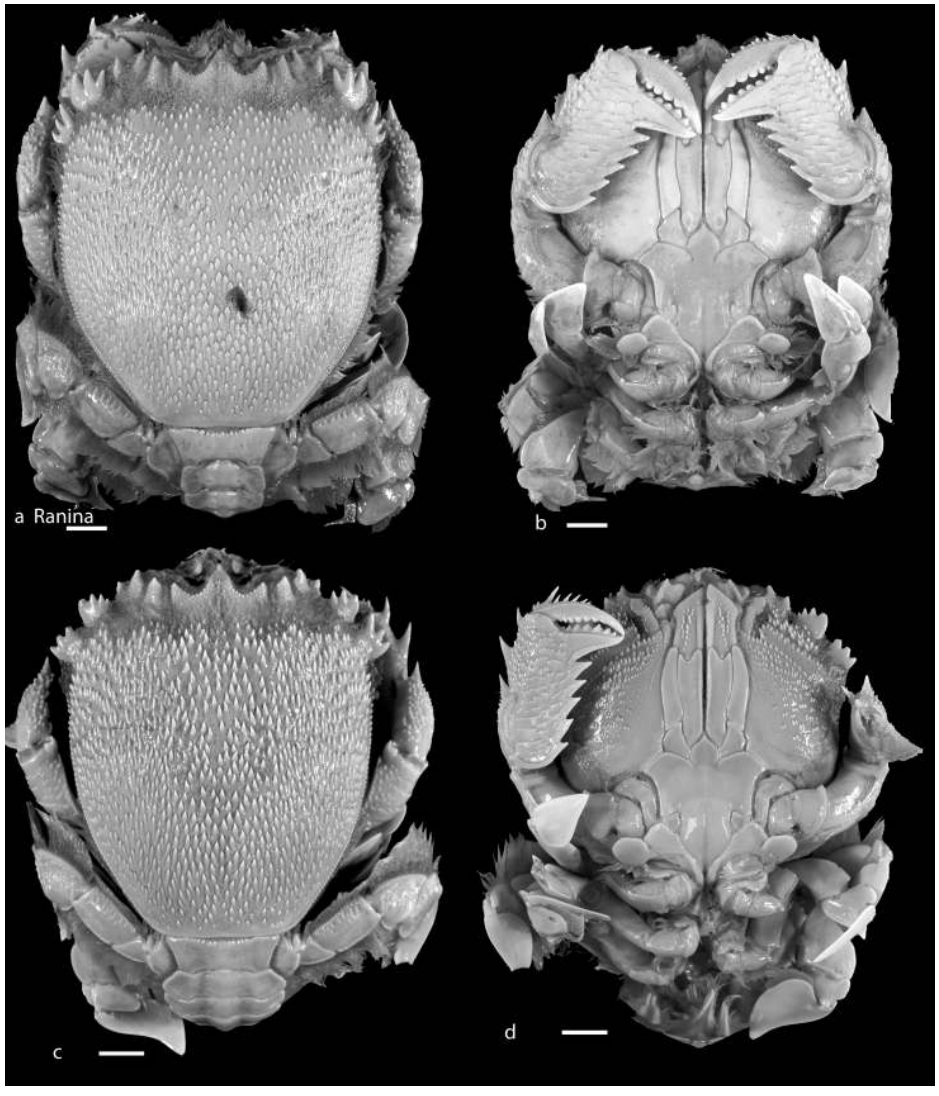


Fig. 16. Raninidae (p. 30).

Eocene (Ypresian)–Oligocene (Chattian): Mexico (Baja California Sur), *Ypresian;* USA (Washington), *Priabonian–Chattian;* Italy, *Rupelian.*——Fig. 17,*1. A. americana* (Withers, 1924), USGS M6553, Priabonian–Chattian, Washington, USA, scale bar, 1 cm (new).

Lophoranina Fabiani, 1910, p. 88 [**Ranina marestiana* König, 1825, p. 2, pl. 1,*15;* OD] [=*Palaeonotopus* Brocchi, 1877, p. 4 (type, *P. barroissii,* p. 5, pl. 29,*6–9,* M)]. Carapace generally widest in anterior one-quarter, narrowing posteriorly; rostrum trifid, axial two spines serving as inner-orbital spines, central spine itself may be trifid; intra- and outer-orbital spines triangular or bifid; anterolateral margin generally with two spines that may be bifid or ornamented with granules or spinelets; post-frontal region depressed slightly below level of remainder of carapace, may be granular or scabrous; carapace surface with well-developed, transverse terraces; terraces relatively narrowly spaced, usually parallel to one another anteriorly, often interfingered with one another or intersecting posteriorly; terraces ornamented with tiny, forward-directed spines; pterygostome, pleonal somites, and appendages ornamented with terraces; sternites 1–5 with scattered, scabrous ornamentation. [Emended from Karasawa & others, 2014, p. 260.] *Eocene (Ypresian)–Miocene:* Indonesia, Italy, *Ypresian;*

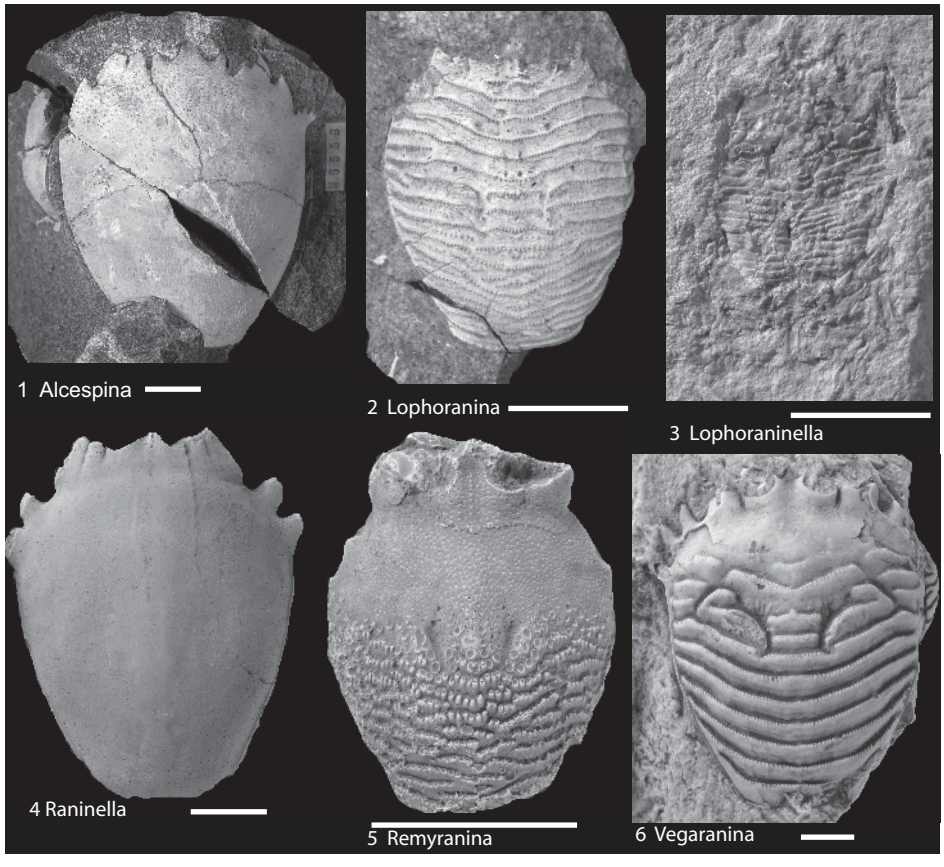


FIG. 17. Raninidae (p. 30–33).

France, Italy, Spain, Israel, Mexico (Chiapas), USA (South Carolina), *Lutetian;* Spain, Italy, Slovakia, Israel, USA (South Carolina), Mexico (Chiapas), *Bartonian;* Italy, Hungary, Slovakia, USA (North Carlina), *Priabonian;* Germany, Italy, Spain, Romania, Greece, Egypt, Iran, Pakistan, India, Japan, Mexico (Baja California Sur), Trinidad and Tobago, USA (Florida), *Eocene;* France, *Rupelian;* Indonesia (Borneo), USA (Alabama), *Oligocene;* Fiji, *Miocene.*——FIG. 17,*2. L. bittneri* (LÓRENTHEY, 1902), MAFI E9312, Eocene, Hungary, scale bar, 1 cm (new; photo by M. Hyžný, Comenius University of Bratislava, Slovakia).

Lophoraninella GLAESSNER, 1946, p. 703 [**Ranina cretacea* DAMES, 1886, p. 553; OD]. Carapace with short, scabrous ornamentation in anterior third, serrate transverse ornamentation on remainder of carapace; sternite 4 appearing widened anteriorly, narrowing posteriorly. [KARASAWA & others, 2014, p. 260.] *Upper Cretaceous (Cenomanian):* Lebanon.——FIG. 17,*3.* **L. cretacea* (DAMES), MSNM i20566, scale bar, 1 cm (new).

Raninella A. MILNE-EDWARDS, 1862, p. 492 [**R. trigeri;* OD]. Carapace ovate, widest about half the distance posteriorly, surface covered by densely spaced, inclined nodes; fronto-orbital width about two-thirds of maximum carapace width; rostrum trifid, axial two spines serving as inner-orbital spines, central spine triangular; intraorbital spine blunt; outer-orbital spine triangular, may be directed forward or outer edge curved axially; anterolateral margin generally with two spines that are flattened, triangular, or more narrow; postfrontal region depressed below level of remainder of carapace, forming a postfrontal ridge; pterygostome with closely spaced nodes; chelipeds may have granular or scabrous ornamentation. [Emended from KARASAWA & others, 2014, p. 261.] *Upper Cretaceous (Cenomanian–Maastrichtian):* France, UK (England), *Cenomanian;* UK, *Turonian;* The Netherlands, *Maastrichtian.*——FIG. 17,*4.* **R. trigeri,* KSU D 1307, cast of paralectotype MNHN R03934, Cenomanian, France, scale bar, 1 cm (new).

Remyranina SCHWEITZER & FELDMANN, 2010, p. 401 [**Raninella ornata* REMY, 1960, p. 57, fig. 2, 8–9; OD]. Small raninine; carapace ovate, widest about half the distance posteriorly on cara-

pace; fronto-orbital width about two-thirds of maximum carapace width, fronto-orbital margin set below level of remainder of carapace; anterolateral margins appearing to have had two projections; carapace ornamentation granular in anterior half and strongly terraced in posterior half, with terraces having small, anteriorly projecting spines. [Emended from Karasawa & others, 2014, p. 261.] *Eocene:* Africa (Ivory Coast).——Fig. 17,*5*. **R. ornata* (Remy), KSU D 1107, cast of holotype, MNHN R03847, scale bar, 1 cm (Schweitzer & Feldmann, 2010, fig. 1A).

Vegaranina van Bakel & others, 2012, p. 95 [**Lophoranina precocious* Feldmann & others, 1996, p. 297, fig. 3–4; OD]. Carapace generally widest in anterior one-quarter, narrowing posteriorly; rostrum trifid, axial two spines serving as inner-orbital spines, central spine itself trifid; intraorbital spine blunt, outer-orbital spine bifid; anterolateral margin generally with three, triangular, flattened spines; post-frontal region depressed slightly below level of remainder of carapace, with scattered granules; carapace surface with well-developed, broadly spaced transverse terraces that are parallel to one another posteriorly and interfingered with one another or intersecting anteriorly; terraces ornamented with tiny, forward-directed spines; pterygostome and appendages ornamented with terraces; sternites 1–5 smooth. [Emended from Karasawa & others, 2014, p. 261.] *Upper Cretaceous (Campanian–Maastrichtian):* Cuba, *Campanian–Maastrichtian;* Mexico (Chiapas), U.S. Territory (Puerto Rico), *Maastrichtian.*——Fig. 17,*6*. **V. precocia* (Feldmann & others), KSU D 642, cast of holotype IHNC 1703, Maastrichtian, Chiapas, Mexico, scale bar, 1 cm (new).

Subfamily RANINOIDINAE Lőrenthey in Lőrenthey & Beurlen, 1929

[Raninoidinae Lőrenthey *in* Lőrenthey & Beurlen, 1929, p. 299]

Carapace elongate; frontal margin generally wide; rostrum and orbital spines well developed, generally long; orbit often with long orbital fissures; anterolateral margin with one spine; sternites 1–4 fused, 1–3 forming cap-like structure, sternite 4 with lateral projections anteriorly and posteriorly; sternite 5 reduced; sternite 6 very long, with wide contact with pleurite 6; sternites 7 and 8 narrow, long; spermathecae very closely spaced; sternum often with longitudinal groove on sternites 5–8; pleon markedly sexually dimorphic, all somites wider in females than in males. [Emended from Karasawa & others, 2014, p. 256.] *Upper Cretaceous (Santonian)–Holocene.*

Raninoides H. Milne Edwards, 1837 in 1834–1840, p. 196 [**Ranina laevis* Latreille, 1825, p. 268; M] [=*Laeviranina* Lőrenthey in Lőrenthey & Beurlen, 1929, p. 105 (type, *Ranina budapestinensis* Lőrenthey, 1898, p. 23, pl. 1,*2,* SD Glaessner, 1929, p. 364); =*Raninellopsis* Böhm, 1922, p. 526 (*R. javana,* M); =*Symnista* Philippi, 1887, p. 215, pl. 50,*6, non* Rafinesque, 1815, p. 98 (crustacean) (type, *S. araucana,* M)]. Carapace longer than wide, length about 70 percent, but may be as low as 60 or as high as 90 percent, of maximum carapace width; rostrum with triangular central spine and triangular lateral spines that also form inner-orbital spines, rostral width about 30 to 40 percent of maximum carapace width; upper orbital margin with open grooves, narrow grooves, or fissures; intraorbital spine well developed; outer-orbital spine bifid; one anterolateral spine; carapace with or without post-frontal ridge; sternites 1–3 fused; sternite 4 long, with anterior and posterior lateral projections and concave between projections; sternite 5 very short and narrow; sternite 6 widening posteriorly, with arcuate, biconcave posterior margin; posterior portion of sternite 4 and sternites 5 and 6 with longitudinal groove. [Emended from Karasawa & others, 2014, p. 258.] *Paleocene (Selandian)–Holocene:* Brazil, western Greenland, *Selandian;* Chile, UK, Germany, Pakistan, *Ypresian;* Germany, Hungary, Italy, Slovakia, New Zealand, USA (Alaska, California, Oregon), *Lutetian;* Germany, Italy, Slovakia, Japan, New Zealand, USA (Alaska, California, Oregon), *Bartonian;* Hungary, Italy, USA (Oregon, Washington),Venezuela, *Priabonian;* Argentina, Brazil, Denmark; Mexico (Baja California Sur), USA (California), *Eocene;* The Netherlands, USA (Oregon), *Chattian;* Taiwan, USA (Washington, Oregon), *Oligocene;* Indonesia (Madura), *Aquitanian–Burdigalian;* Taiwan, Borneo, Java, Mexico (Baja California Sur, Veracruz), *Miocene;* Spain, *Tortonian;* Taiwan, Panama, *Tortonian–Pleistocene;* Panama, Venezuela, *Miocene;* Curaçao, Italy, *Pliocene;* Costa Rica, Jamaica, Philippines, *Pleistocene;* Cosmopolitan, *Holocene.*——Fig. 18,*1a–b*. *R. fulgidus* Rathbun, 1926a, Eocene, Washington, USA; *a*, KSU D 667, dorsal carapace; *b*, KSU D 2161, sternum, scale bars, 1 cm (Karasawa & others, 2014, fig. 15).

Bonizzatoides Beschin, Busulini, & Tessier, 2013, p. 117, pl. 1,*4,* 2,*1* [**B. tuberculatus;* OD]. Carapace long, transversally convex; fronto-orbital margin wide; rostrum wide, with three, well-developed, triangular spines, middle one largest; small, triangular upper orbital spine; outer-orbital spine sharp; short, convex anterolateral margins with small spine; long, weakly concave, convergent posterolateral margins; short fronto-orbital region bounded by a weak, sinuous ridge; dorsal carapace regions not defined; carapace surface smooth, with one tubercle on each protogastric region, two on mesogastric and cardiac regions; isolated tubercles on branchial region; wide thoracic sternite 4 with transverse anterior margin; sternite 5 very wide;

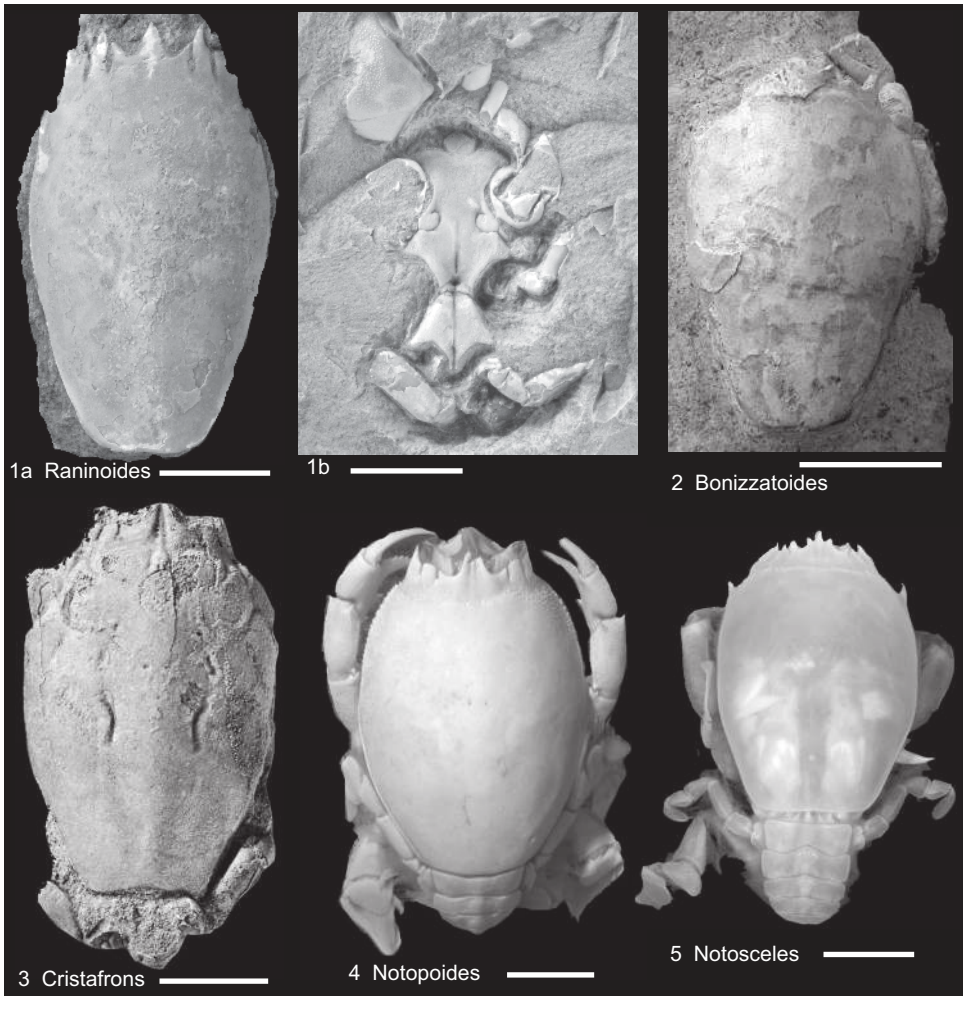


FIG. 18. Raninidae (p. 33–35).

sternites 5 and 6 axially sulcate; upper margins of chelae smooth. [Emended from BESCHIN, BUSULINI, & TESSIER, 2013, p. 118.] *Eocene (Lutetian):* Italy.——FIG. 18,*2*. **B. tuberculatus,* holotype, MCZ 23480, scale bar, 1 cm (Beschin, Busulini, & Tessier, 2013, pl. 1,*4,*).

Cristafrons FELDMANN, TSHUDY, & THOMSON, 1993, p. 31, fig. 25 [**C. praescientis;* OD]. Carapace ovate; rostrum with long, triangular central spine axially broadly sulcate and with keel in sulcus, two spines to either side of central rostral spine, short, forming inner-orbital spines; intraorbital spine not projecting beyond orbital rim, bounded by open fissures; outer-orbital spine long, as long as or longer than rostrum; anterolateral spine stout at base, becoming more slender distally; post-frontal ridge sinuous; cervical groove deep. [Emended from KARASAWA & others, 2014, p. 257.] *Upper Cretaceous (Santonian–Campanian):* West Antarctica.——FIG. 18,*3*. **C. praescientis,* holotype, BAS In. 2233, scale bar, 1 cm (new; photo by Pete Bucktrout, British Antarctica Survey, Cambridge, UK).

Notopoides HENDERSON, 1888, p. 29, pl. 3,*1* [**N. latus;* M]. Carapace obovate, widest in anterior third; rostrum triangular, with two short, spines on either side of central rostral spine, forming inner-orbital spines; intraorbital spine triangular, bounded by open fissures; outer-orbital spine triangular; anterolateral margins entire or with tiny serrations; post-frontal ridge very well developed. [Emended from KARASAWA & others, 2014, p. 257.] *Upper Cretaceous (Campanian)–Holocene:* USA (Texas), *Campanian;* Italy, *Ypresian–Lutetian;* Mexico (Coahuila), *Eocene;* Java, *Miocene;* Indo-Pacific, *Holocene.*——FIG. 18,*4*. **N. latus,* Senckenberg Forschungsinstitut und Naturmuseum,

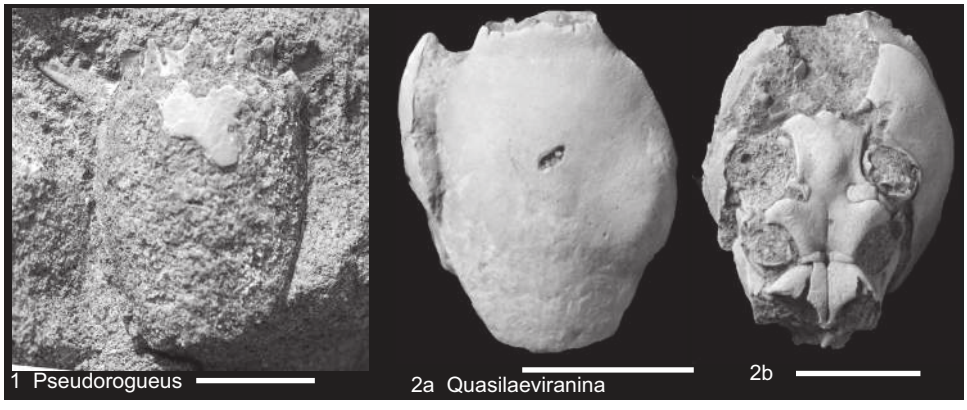


FIG. 19. Raninidae (p. 35).

Frankfurt, Holocene, Indo-Pacific Oceans, scale bar, 1 cm (new).

Notosceles BOURNE, 1922, p. 73, pl. 4,*2–3* [**N. chimmonis;* M]. Carapace elongate-rectangular; rostrum with triangular central spine that is itself serrate and two, short spines to either side of central rostral spine forming serrate inner-orbital spines; intraorbital spine triangular, short, and bounded by short, open fissures; outer-orbital spine triangular; anterolateral spine positioned only a short distance from outer-orbital spine. [Emended from KARASAWA & others, 2014, p. 257.] *Paleocene–Holocene:* USA (Alabama, Arkansas, Texas), *Paleocene–Eocene;* Indo-Pacific Oceans, *Holocene.*——FIG. 18,*5*. **N. chimmonis,* USNM 134655, Holocene, Seychelles Islands, scale bar, 1 cm (new).

Pseudorogueus FRAAYE, 1995, p. 66, fig. 1–2 [**P. rangiferus;* OD]. Carapace ovate; rostrum trifid, lateral two spines forming inner-orbital spines; intraorbital spine long, bounded by open fissures; outer-orbital spine bifid, outer branch longer than inner; anterolateral spine long, with three, small spines on upper surface. [KARASAWA & others, 2014, p. 257.] *Eocene (Ypresian):* Spain.——FIG. 19,*1*. **P. rangiferous,* MAB k 1040, dorsal carapace, scale bar, 1 cm (new; photo by R. Fraaije, Oertijdmuseum De Groene Poort, Boxtel, The Netherlands).

Quasilaeviranina TUCKER, 1998, p. 355 [**Ranina simplicissima* BITTNER, 1883, p. 305, pl. 1,*4;* OD]. Carapace ovate, wide for subfamily; rostrum triangular with two, short spines to either side of central rostral spine forming inner-orbital spines; intraorbital spine triangular, bounded by closed fissures; outer-orbital spine triangular; post-frontal ridge well developed. [Emended from KARASAWA & others, 2014, p. 257.] *Upper Cretaceous (Santonian–Maastrichtian)–Eocene:* Colombia, *Santonian–Maastrichtian;* USA (Alabama), *Paleocene–Eocene (Ypresian);* New Zealand, *Lutetian;* Italy, *Lutetian–Bartonian;* New Zealand, *Priabonian;* Mexico (Coahuila), *Eocene.*——FIG. 19,*2a–b*. *Q. ovalis* (RATHBUN, 1935), USNM 371689, 2 of 32 syntypes, Paleocene, Alabama, USA; *a*, dorsal carapace with probable bopyrid isopod swelling in right branchial chamber; *b*, ventral surface, scale bars, 1 cm (new).

Subfamily SYMETHINAE Goeke, 1981

[Symethinae GOEKE, 1981, p. 972]

Carapace elongate, ovoid, widest at mid-length; rostrum extended well beyond anterolateral margin; eyes very small; fronto-orbital width about half maximum carapace width, inner-orbital fissure absent, outer-orbital fissure weak, inner and outer-orbital lobes absent; carapace with anterior to cervical groove deeply pitted; buccal cavity elongate, narrow, completely closed by third maxilliped that lies in two planes; pterygostome-sternum junction very narrow; sternum with spermathecae well separated, hooded; sternite 3 clearly divided from sternite 4; sternite 5 medially raised; sternite 6 very narrow; pleon sexually dimorphic, triangular in males, broad and parallel sided in females. Cheliped with carpus-propodus articulation transverse to long axis of arm, fixed finger and dactylus not strongly deflected; pereiopods 2–5 with crescentic dactyli; pereiopod 5 subdorsal, coxa large. [Emended from KARASAWA & others, 2014, p. 258.] *Upper Cretaceous (Maastrichtian)–Holocene.*

Symethis WEBER, 1795, p. 92 [**Hippa variolosa* FABRICIUS, 1787, p. 330; M]. Carapace ovate, convex from side to side and from before backward, its surface partly uneven. Fronto-orbital

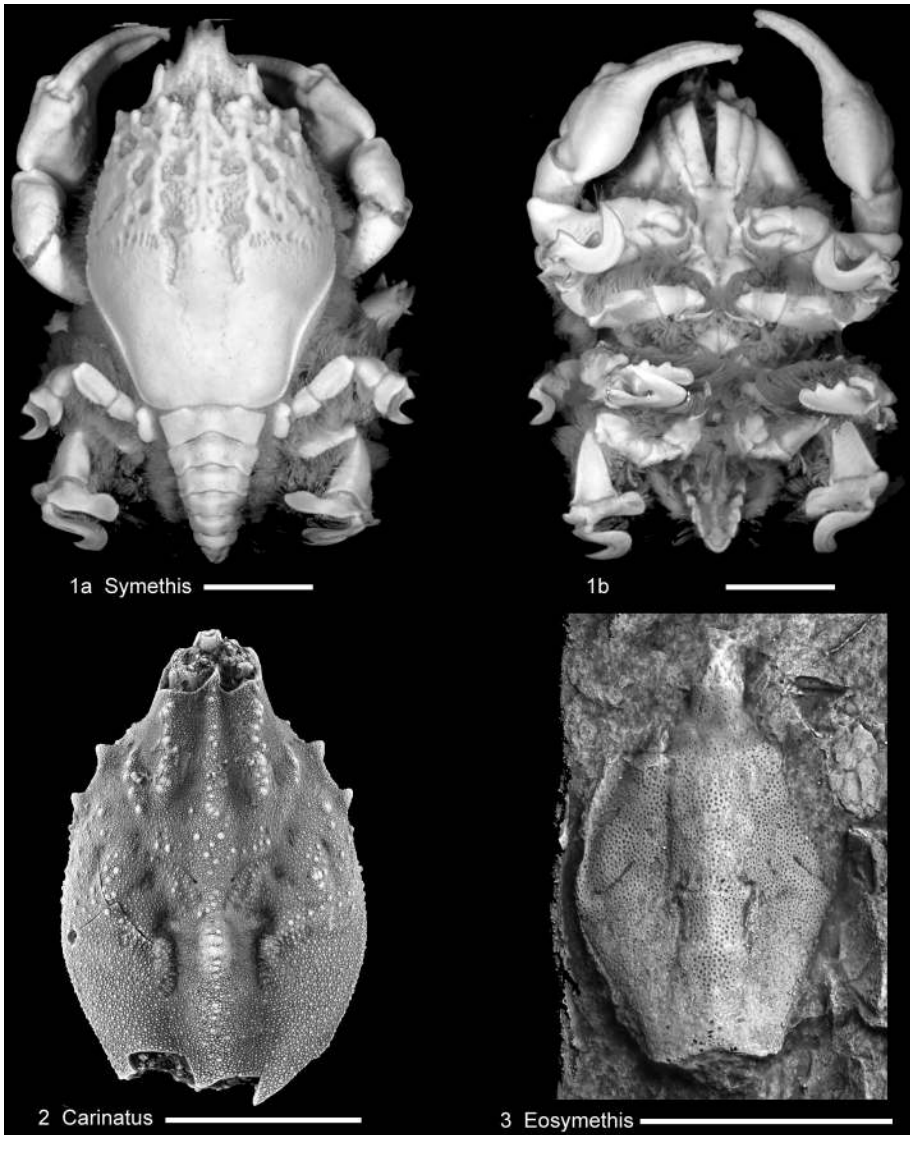


FIG. 20. Raninidae (p. 35–37).

border very narrow, considerably less than half the width of carapace, frontal region trilobate produced anteriorly. Eyes rudimentary, placed in ill-defined orbits; the peduncles short, and the corneae of small size though pigmented. Antennal peduncle massive, first segment fused with carapace, second with a very prominent external prolongation; flagellum short. Antennules small, completely concealed by the antennal peduncles, which meet in the middle line. Outer maxillipeds moderately broad, ischium twice the length of the merus. Sternal thoracic shield narrow, becoming linear between ambulatory legs of first pair, but slightly dilating again between first and second pairs. Chelipeds of considerable length, propodus swollen laterally, fingers long. Ambulatories with uncinate dactyli, last pair of small size but not filiform. Male generative appendages similar to but shorter than those of *Raninoides*. [RATHBUN, 1937b, p. 24.] *Holocene:* Australia, eastern Pacific and western Atlantic Oceans.——FIG. 20,*1a–b*. **S. variolosa* (FABRICIUS), USNM 273398, Gulf of Mexico; dorsal (*a*) and ventral (*b*) views, scale bars, 1 cm (new).

Carinatus Nyborg & others, 2017, p. 294, fig. 3 [**C. galebishopi;* OD]. Carapace elongate, appearing to be widest at about half or slightly more than half of the distance posteriorly; fronto-orbital width extremely narrow, less than half maximum carapace width; anterolateral margin with two, short spines and some granules; mesogastric and protogastric regions defined by weak inflation, with longitudinal ridges of tubercles and granules; urogastric region with strong tubercles; branchiocardiac groove deep axially, defining lateral margins of urogastric region; entire carapace surface with broadly spaced granules. *Upper Cretaceous (Maastrichtian):* USA (Mississippi).——Fig. 20,*2. *C. galebishopi,* holotype, MMNS IP-2716, scale bar, 1 cm (new; photo by B. W. M. van Bakel, Oertijdmuseum De Groene Poort, Boxtel, The Netherlands).

Eosymethis van Bakel & others, 2012, p. 104, fig. 32 [**E. aragonensis;* OD]. Carapace ovate, longer than wide if rostral length included, and surface punctate; anterolateral margin sinuous, longer than posterolateral margin; posterolateral margin concave; axial region of carapace somewhat inflated; branchiocardiac groove developed as arcs on either side of axis, with straight segment on either side of carapace extending anteriorly from anterolateral corner; rostrum with straight margin at base, then coming to triangular tip; at least one pair of pereiopods with sickle-like dactyl. [Emended from Karasawa & others, 2014, p. 258.] *Eocene (Ypresian):* Spain.——Fig. 20,*3. *E. aragonensis,* holotype, MGSB 75293, scale bar, 1 cm (new; photo by B. W. M. van Bakel, Oertijdmuseum De Groene Poort, Boxtel, The Netherlands).

ABBREVIATIONS FOR MUSEUM REPOSITORIES

ANSP: Academy of Natural Sciences of Philadelphia, Academy of Natural Sciences of Drexel University, Philadelphia, Pennsylvania, USA
BAS: British Antarctic Survey, Cambridge, UK
BMNH, The Natural History Museum, London, UK
BSP: Bayerische Staatsammlung für Paläontologie und historische Geologie München (Munich), Germany
CAS: California Academy of Sciences, Fossil Collection, San Francisco, California, USA
CDM: Courtenay and District Museum, Palaeontology Centre, Vancouver Island, British Columbia, Canada
CIRGEO: Centro de Investigaciones en Recursos Geológicos, Buenos Aires, Argentina
GBA: Geologische Bundesanstalt (Geological Survey of Austria), Vienna, Austria
GSC: Geological Survey of Canada, Eastern Paleontology Division, Ottawa, Ontario, Canada;
I: Manitoba Museum, Winnipeg, Manitoba, Canada
IGM: Colombian Geological Survey, Bogotá, Colombia
IHNC: Instituto de Historia Naturel del Estado de Chiapas, Tuxtla Gutiérrez, Chiapas, Mexico
IRScNB: Institut Royal des Sciences Naturelles de Belgique, Paleontology Collections, Brussels, Belgium
JSHC: Joe H. S. Collins Collection, London, England
KSU D: Decapod Comparative Collection, Department of Geology, Kent State University, Kent, Ohio, USA
LO: Department of Geology, Lund University, Lund, Sweden
MAB k: Oertijdmuseum De Groene Poort, Boxtel, The Netherlands
MAFI: Földani Intézet (Hungarian Geological Survey), Budapest, Hungary
MBA: Humboldt-Universitat zu Berlin Museum, Berlin, Germany
MCV: Museo Civico "D. Dal Lago" di Valdagno (Vicenza), Italy
MCZ: Museo Civico "G. Zannato" di Montecchio Maggiore (Vicenza), Italy
MFM: Mizunami Fossil Museum, Mizunami, Gifu, Japan
MGSB: Museo Geológico del Seminario de Barcelona, Barcelona, Spain
MGUH: Geologisk Museum, University of Copenhagen, Copenhagen, Denmark
MHN LM: Natural History Museum of Le Mans ("Musée vert"), Le Mans, France
MMNS: Mississippi Museum of Natural Science, Jackson, Mississippi, USA
MNHN.F: Muséum National d'histoire naturelle, Paris, Collection de Paléontologie, France
MSN UniFl: Museo di Storia Naturale, Università degli Studi Firenze, Italy
MSNM: Museo Civico di Storia Naturale di Milano, Italy
NHMM: Naturhistorisch Museum Maastricht, The Netherlands
NJSM: New Jersey State Museum, Trenton, New Jersey, USA
NMNS: National Museum of Natural Science, Taichung, Taiwan
PI: Charleston Museum, Charleston, South Carolina, USA
PKNM: Národní Muzeum, Prague, Czech Republic
SDSMT: South Dakota School of Mines and Technology, Rapid City, South Dakota, USA
SDSNH: San Diego Museum of Natural History, San Diego, California, USA
SM B: Sedgwick Museum, Cambridge University, UK
TMM: UT, University of Texas at Austin, Texas, USA
UNAM: Universidad Autónoma de México, Mexico D.F., Mexico
USNM: United States National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA
USGS: United States Geological Survey, housed in United States National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA
USP: Instituto de Geociências da Universidade São Paulo, São Paulo, Brazil

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