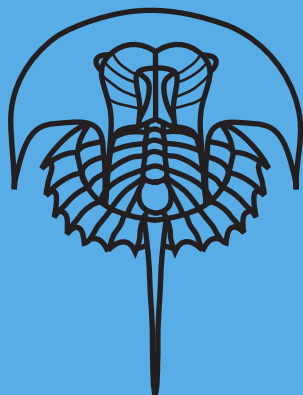




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SYSTEMATIC DESCRIPTIONS: CYCLIDA

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Cyclidans are unusual, extinct crustaceans that have recently received renewed attention (MYCHKO & OTHERS, 2019, 2022; MYCHKO, ALEKSEEV, & SCHWEITZER, 2025; MYCHKO, 2025; SCHWEITZER, MYCHKO, & FELDMANN, 2020; SCHWEITZER, MYCHKO, & LEHNERT, 2025). Because their morphology is likely unfamiliar to most paleontologists, each genus is illustrated with a photograph and a labeled drawing. Morphology abbreviations follow FELDMANN & SCHWEITZER (2019).

MORPHOLOGY ABBREVIATIONS

a1: antennule	mx: maxilla
a2: antennae	mxd: maxilliped
abd: abdomen	obr: outer branchial region
ak: axial keel	ocs: ovate central structure of sternum
al 1–al 3: axial lobes 1–3	olk: outer lyrate keel
alp: outer orbital tooth	omck: outer median concentric keel
ap: appendage	on: optic notch
br: branchial region	op: orbital process
cd: concentric depression	pal: posterior axial lobe
cm: marginal carapace cornice	p, pap: papillae
cn: crenulate edge of carapace	pc: small circular pit
cr: caudal rami	pn: posterior notch in marginal rim
eb: raised orbital rim	r: rostral plate
g: gills	sp: sunken pit
G1: gonopod	t2–t6: thoracic appendages
gr1–gr4: arcuate, transverse granular ridge	tb: tubercle
ibr: inner branchial region	tc: transverse crest
ilk: inner lyrate keel	th: thoracic somites (sternal)
imck: inner median concentric keel	tr: thoracic ridges (dorsal)
ll 1–ll 3: lateral lobes 1–3	vl: ventral lugs
mck: median concentric keel	x: anterior or post-optic bulge
mr: marginal rim	y: posterior or cardiac bulge

Order CYCLIDA Schram, Vonk, & Hof, 1997

[*nom. correct.* DZIK, 2008, p. 1517,
pro Cycloidea SCHRAM, VONK, & HOF,
1997, p. 264]

Pancrustaceans with domed or flattened carapace covering cephalic and thoracic regions, carapace oval to subcircular in outline, usually with a marginal rim; eyes stalked; antennules stout and long, antennae much reduced; mandibles ovate, well-calcified; thoracomeres expressed ventrally, usually six or seven somites visible, thoracic segmentation occasionally expressed as dorsal carapace ridges; at least nine pairs of appendages excluding antennae and antennules, including mandibles, maxillae, maxillules, maxillipeds, and five additional thoracic appendages; maxillae, maxillules, and maxillipeds subchelate; other thoracic appendages with sharp dactyli; gills forming horseshoe-shaped lamellate structure (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 247). *Lower Mississippian (Tournaisian)–Upper Cretaceous (Maastrichtian)*.

Superfamily CYCLOIDEA Packard, 1885

[*nom. transl.* GLAESSNER, 1928, p. 394,
ex Cyclidae PACKARD, 1885, p. 293]

As for order. *Lower Mississippian (Tournaisian)–Upper Cretaceous (Maastrichtian)*.

Family CYCLIDAE Packard, 1885

[Cyclidae PACKARD, 1885, p. 293]

Carapace small, outline circular or ovate; strongly domed, highest in posterior half; carapace with marginal rim, rim sometimes with posterior notch; carapace surface granular, with clearly or poorly defined regions, always with posterior axial keel; carapace lobes exhibiting varying degrees of development, posterior axial lobe always present; branchial regions granular, sometimes with

thoracic ridges (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 247). *Lower Mississippian (Tournaisian)–Permian (Guadalupian, Wordian)*

Cyclus DE KONINCK, 1841, p. 13 [**Agnostus? radialis* PHILLIPS, 1836, p. 240, pl. 22,25; M]. Carapace ovate to subcircular, strongly vaulted transversely and longitudinally; with well-developed, smooth marginal rim, posterior notch wide; axial and lateral lobes well-developed; inner and outer lyrate keels present, posterior axial keel strong; about seven very well-defined thoracic ridges, extending from axial regions to marginal rim, inner and outer branchial regions not differentiated (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 247). *Lower (Tournaisian)?–Middle Mississippian (Visean)*: Belgium, Ireland, UK (England & Scotland).—FIG. 1, 1*a-b*. **Cyclus radialis* (PHILLIPS), MM L.11676, Visean, England; *a*, dorsal carapace; *b*, labeled drawing; scale bars = 5 mm (SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 1.1, 1.4).

Ambocyclus SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 253 [**Cyclus simulans* REED, 1908, p. 551; OD]. Carapace ovate, strongly vaulted longitudinally and transversely, highest at about midlength; axial and lateral lobes moderately developed; axial area continuous with branchial regions on either side, forming a large ovate area centrally on carapace; very strong median concentric keel; carapace surface relatively smooth, smooth flattened marginal rim at least anterolaterally (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 253). *Lower (Tournaisian) - Middle (Visean) Mississippian*: Ireland. *Middle Mississippian (Visean)–Lower Pennsylvanian (Bashkirian)*: Russia. *Upper Pennsylvanian (Kasimovian)*: USA (Missouri).—FIG. 1, 2*a-b*. **Ambocyclus simulans* (REED), SM E3724a, Visean, Ireland; holotype; *a*, dorsal carapace; *b*, labeled drawing; scale bar = 5 mm (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 4.1, 4.2).

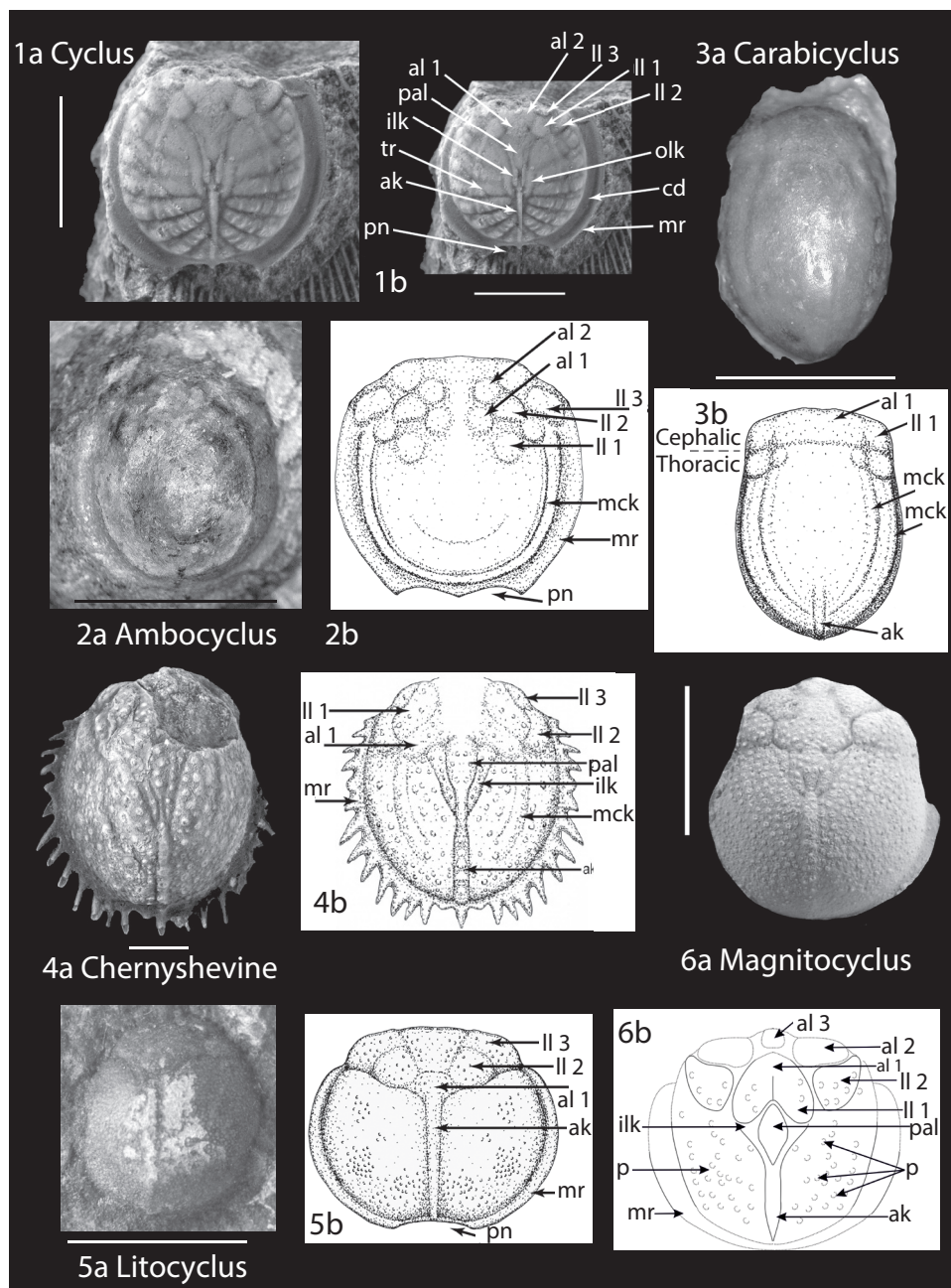


FIG. 1. Cyclidae.

Carabicyclus SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 255 [**Cyclus wrighti* WOODWARD, 1870, p. 555, pl. 23, 4; OD]. Carapace longer than wide, ovate, narrowing to a blunt tip posteriorly, anterior

margin wide; carapace divided by transverse shallow groove into distinct cephalic and thoracic regions; cephalic region with an axial lobe and a pair of first lateral lobes; two median concentric keels, each keel

terminating anteriorly in an ovate swelling; axial keel developed posteriorly; marginal rim absent or not preserved (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 255). *Middle Mississippian (Visean)*: UK (England), Ireland.—FIG. 1, 3*a-b*. **Carabicyclus wrighti* (WOODWARD), NHMUK I.15513, holotype, Visean, Ireland; *a*, dorsal carapace; *b*, labeled drawing; scale bar = 5 mm (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 5.1, 5.2).

Chernyshevine SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 260 [**Cyclus spinosus* CHERNYSHEV, 1933, p. 20, pl. 1,9; OD] [= *Cyclus tuberosus* CHERNYSHEV, 1933, p. 20, pl. 1, fig. 10]. Carapace longer than wide, ovate; carapace lobes well-developed, inner lyrate keel present, median concentric keel weak, carapace surface coarsely granular; marginal rim flattened, with long, distinct spines (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 260). *Middle Mississippian (Visean)*: Tajikistan.—FIG. 1, 4*a-b*. **Chernyshevine spinosus* (CHERNYSHEV), TsNIGR 12/3694, holotype, Visean, Tajikistan; *a*, dorsal carapace; *b*, labeled drawing; scale bar = 5 mm (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 7.1, 7.2).

Litocyclus SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 257 [**Cyclus bilobatus* WOODWARD, 1870, p. 554, pl. 23.3; OD]. Carapace with subdued ornamentation, strongly vaulted; axial keel strong or weak; median concentric keel absent; axial and lateral lobes present but very weakly defined; carapace surface granular; marginal rim smooth, narrow (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 257). *Lower Mississippian (Tournaisian)?*: UK (England), Ireland. *Middle Mississippian (Visean)*: UK (England), Ireland. *Upper Pennsylvanian (Kasimovian)*: USA (Missouri).—FIG. 1, 5*a-b*. **Litocyclus bilobatus* (WOODWARD), SM E706, holotype, Visean, England; *a*, dorsal carapace; *b*, labeled drawing; scale bar = 5 mm (adapted

from SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 6.1, 6.2).

Magnitocyclus MYCHKO & OTHERS, 2022, p. 80 [**M. struveae*; OD]. Carapace longer than wide, ovate; carapace lobes well-defined; posterior axial lobe, first and second lateral lobes, and anterior lobes 1–3 all well-developed; inner lyrate keel weak, posterior axial keel moderately well-developed; carapace surface granular overall (adapted from MYCHKO & OTHERS, 2022, p. 80). *Middle Mississippian (Visean)*: UK (Scotland). *Middle–Upper Mississippian (Visean–Serpukhovian)*: Russia.—FIG. 1, 6*a-b*. **Magnitocyclus struveae*, PIN no. 5871/1, holotype, Visean–Serpukhovian, Russia; *a*, dorsal carapace; *b*, labeled drawing; scale bar = 5 mm (*a*, adapted from MYCHKO & OTHERS, 2022, fig. 4*a*; *b*, adapted from MYCHKO, ALEKSEEV, & SCHWEITZER, 2025, fig. 8).

Missouriclus SCHWEITZER, MYCHKO, & LEHNERT, 2025, p. 7 [**Cyclus communis* ROGERS, 1902, p. 270, pl. 14,1; OD]. Carapace ovate, moderately vaulted longitudinally; lateral lobes 1 and 2 and anterior lobe 1 diamond-shaped, smooth; axial keel short; branchial regions not differentiated, no evidence of keels, ornamented with coarse, evenly spaced tubercles (adapted from SCHWEITZER & OTHERS, 2025, p. 7). *Upper Pennsylvanian (Kasimovian)*: USA (Kansas, Missouri).—FIG. 2, 1*a-b*. **Missouriclus communis* (ROGERS), AMNH-FI-144361, lectotype, Kasimovian, Missouri; *a*, dorsal carapace; *b*, labeled drawing; scale bar = 5 mm (adapted from SCHWEITZER, MYCHKO, & LEHNERT, 2025, fig. 4*A*, 5*C*).

Paraprosopon GEMMELLARO, 1890, p. 22 [**P. reussi*, p. 23, pl. 3,22, pl. 5,2; M]. Carapace ovate, wider posteriorly; posterior axial lobe and axial lobes 1 and 2 and lateral lobe 1 apparently well-defined; branchial regions separated by axial keel (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 285). *Permian (Guadalupian, Wordian)*:

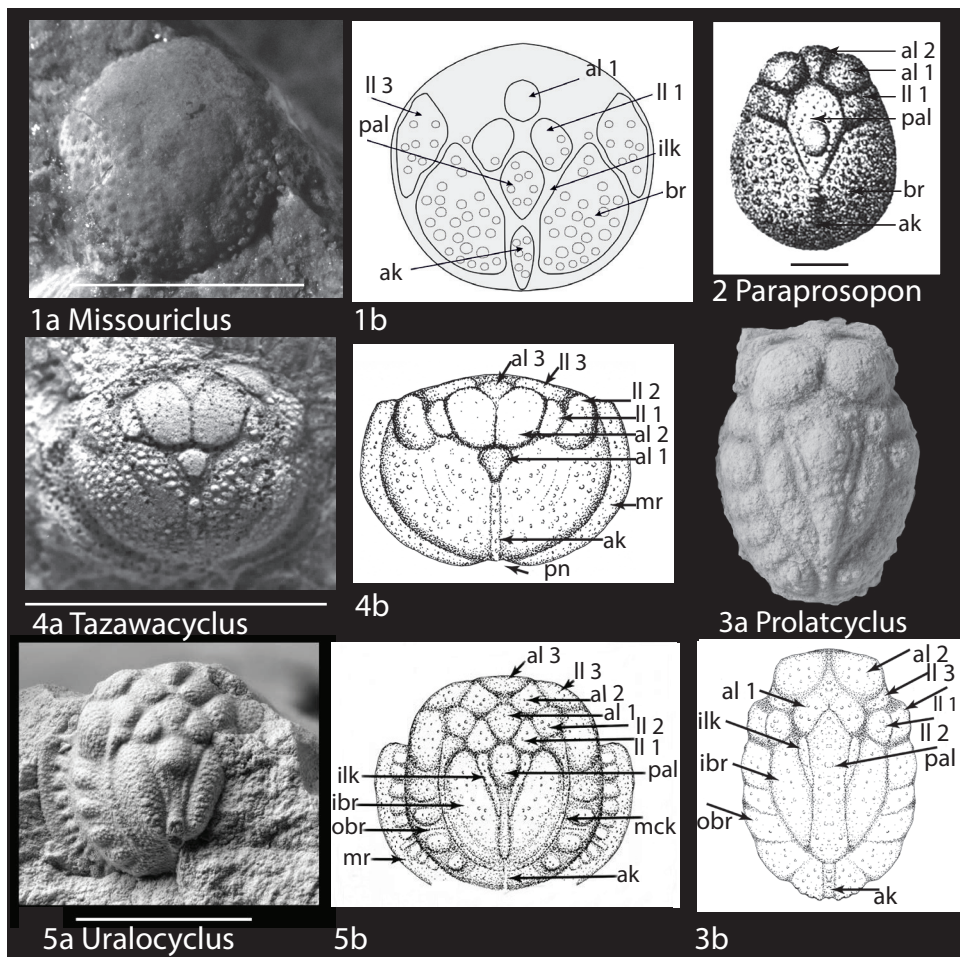


FIG. 2. Cyclida.

Italy.—FIG. 2,2. **P. reussi*, labeled image from GEMMELLARO (1890, pl. 3,22) (holotype apparently lost); scale bar = 1 mm (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 19).

Prolatcycylus MYCHKO & OTHERS, 2019, p. 85 [**Cycylus martinensis* GOLDRING, 1967, p. 318, fig. 1–8; OD]. Carapace elongate-ovate, longer than wide; posterior axial lobe strong, confluent with axial keel; first axial lobe chevron-shaped; second axial lobes very large; third axial and lateral lobes smaller; inner lyrate keel present; inner and outer branchial regions well-defined, separated by median concentric groove, outer

branchial region separated into six thoracic ridges (adapted from MYCHKO & OTHERS, 2019). *Middle Mississippian (Visean)*: UK (England), Russia.—FIG. 2,3a–b. **Prolatcycylus martinensis* (Goldring), GSM 102640, paratype, Visean, England; *a*, dorsal carapace; *b*, labeled drawing; scale bar = 5 mm (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 2.1, 2.2).

Tazawacyclus SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 260 [**Cycylus tazawai* NIKO & IBARAKI, 2011, p. 259, fig. 1, 2; OD]. Carapace ovate, wider than long; marginal rim well-developed, ornamented with tubercles, narrowing posteriorly, poste-

rior notch wide; posterior axial keel strong; posterior axial lobe absent, first axial lobe small, wide anteriorly; second axial lobe very large, sharing a long, straight axial edge; third axial lobe small; first lateral lobe positioned at posterolateral corner of second axial lobe, longer than wide; second lateral lobe reniform; third lateral lobe transversely ovate, anterior to second axial lobe (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 261). *Upper Mississippian (Serpukhovian)*: Japan.—FIG. 2, 4a–b. **Tazawacyclus tazawai* (NIKO & IBARAKI), FMM 1998, holotype, Serpukhovian, Japan; *a*, dorsal carapace; *b*, labeled drawing; scale bar = 5 mm (photograph originally published in NIKO & IBARAKI [2011, fig. 1A] in Journal of the Geological Society of Japan; adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 8).

Uralocyclus MYCHKO & ALEKSEEV, 2018, p. 30 [**Cyclus miloradovitchi* KRAMARENKO, 1961, p. 87, pl. 12; OD]. Carapace ovate, moderately vaulted; strong marginal rim which is ornamented with transversely elongate tubercles which extend from the circular depression to about half the width of the rim, rim appearing to narrow posteriorly; third lateral lobe reniform; first and second lateral and all three axial lobes diamond-shaped, about the same size; inner lyrate keel weak, outer lyrate keel absent, median concentric keel strong; inner branchial region granular, outer branchial region with at least five and as many as seven ovate, transverse swellings (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 251). *Lower–Middle Mississippian (Tournaisian–Visean)*: UK (England). *Middle Mississippian (Visean)*: Ireland, Russia. *Upper Mississippian (Serpukhovian)*: Russia. *Permian (Cisuralian, Asselian)*: Russia.—FIG. 2, 5a–b. **Uralocyclus miloradovitchi* (KRAMARENKO), PIN no. 1792/3, paratype, Asselian, Russia; *a*, dorsal carapace; *b*, labeled drawing; scale bar = 5 mm (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 3.1, 3.3).

Family ALSASUACARIDAE Van Bakel, Jagt, Fraaije & Artal, 2011

[Alsasuacaridae VAN BAKEL & OTHERS, 2011, p. 48]

Carapace overall ovate; rostrum may extend well beyond orbits or only moderately, rostrum very wide to narrow, always widest distally and narrowing to base; orbits well-defined, may be directed anteriorly or anterolaterally; carapace surface densely or sparsely granular; with rim posteriorly; carapace regions defined anteriorly (SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 261). *Lower Cretaceous (Albian)–Upper Cretaceous (Maastrichtian)*.

Alsasuacaris VAN BAKEL & OTHERS, 2011, p. 48, fig. 1, 2 [**A. nostradamus*; OD]. Carapace small, ovate overall; orbits large, directed anterolaterally, orbital margin thickened, outer orbital tooth very strong; very large, fan-shaped rostrum, with raised crest parallel to distal margin and axial depression; posterior margin rounded, with sloping shelf; carapace surface areolated, posterior portion covered with multiple subcircular, parallel ridges; cuticle granular (adapted from VAN BAKEL & OTHERS, 2011, p. 48). *Lower Cretaceous (Albian)–Upper Cretaceous (Cenomanian)*: Spain. *Upper Cretaceous (Maastrichtian)*: Netherlands.—FIG. 3, 1a–b. **A. nostradamus*, cast of holotype MGSB 75.424 Albian–Cenomanian, Spain; *a*, dorsal carapace; *b*, labeled drawing; scale bar = 1 mm (photo by Barry van Bakel; adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 9.3, 9.4).

Maastrichtiocaris FRAAIJE, SCHRAM, & VONK, 2003, p. 386, fig. 1 [**M. rostrata*; OD]. Carapace oval, broadly flattened along posterior and posterolateral margins; surface finely granular; posterior margin granular; orbits wide, with sinuous orbital margin, directed forward; rostrum narrow at base and widened distally (adapted from FRAAIJE & OTHERS, 2003, p. 386). *Upper Creta-*

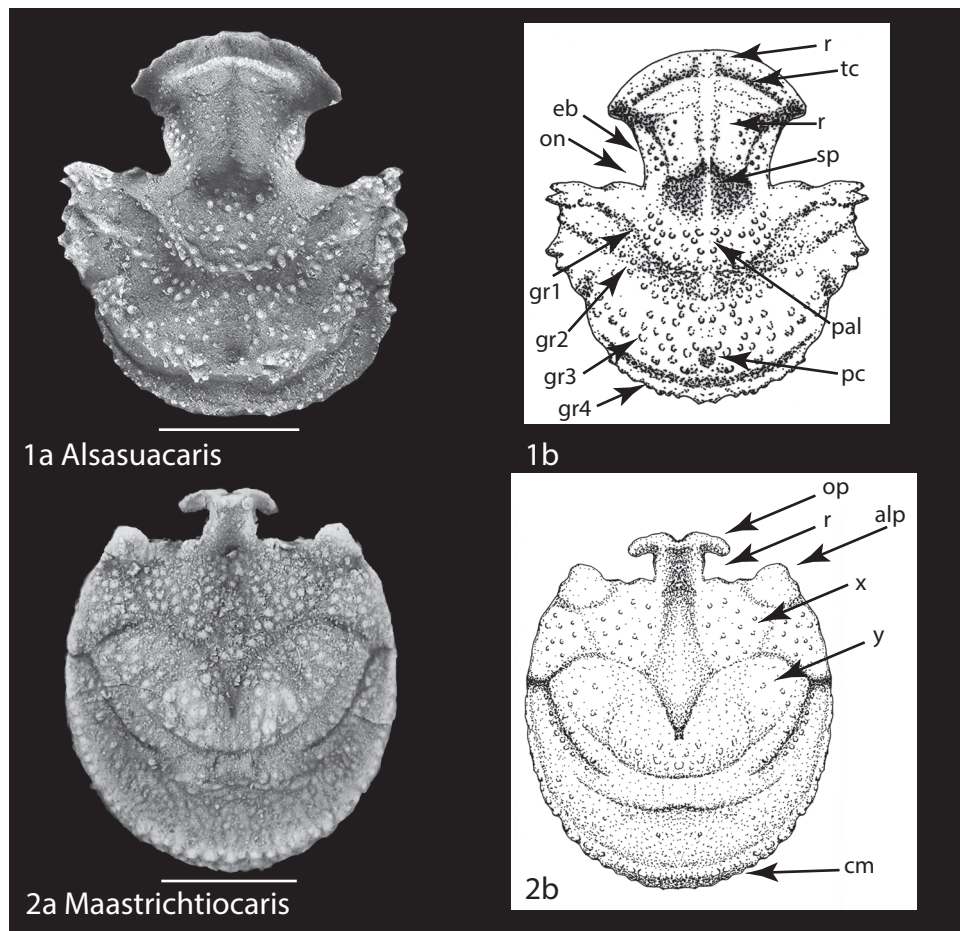


FIG. 3. Alsasuacaridae.

ceous (Maastrichtian): Netherlands.—
FIG. 3, 2a–b. **M. rostrata*, MAB k 1399, holotype, Maastrichtian, Netherlands; *a*, dorsal carapace; *b*, labeled drawing; scale bar = 1 mm (photo by Barry van Bakel; adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 9.1, 9.2).

Family AMERICLIDAE Dzik, 2008

[Americlidae Dzik, 2008, p. 1517]

Carapace flattened, from about as wide as long to wider than long, bilobed; weak to moderate carapace regional definition; marginal rim well-developed, wide, may be

serrate, with posterior notch or continuous; carapace surface smooth or granular; inner and outer lyrate keels usually present, one or two median concentric keels, posterior axial keel short; rostral lobe extending beyond carapace, usually with optic notches; gills arranged as tiny parallel filaments in a horseshoe-shaped structure; first antennae strong, thick, with long flagella; second antennae slender, shorter; first pair of visible non-antennal appendages short; two pairs of subchelate appendages with sickle-like dactyls; five pediform thoracic appendages posterior to subchelate appendages; male gonopod present, interpreted as a modified exopod of last thoracic appendage; caudal rami present; sternal region with seven

visible, well-defined somites, ovate central sternal area; abdomen with 2–4 somites (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 264). *Middle Mississippian (Visean)–Upper Pennsylvanian (Kasimovian)*.

Americlus DZIK, 2008, p. 1517 [**Cyclus americanus* PACKARD, 1885, p. 143., pl. V, I, pl. VI, 4; OD]. Carapace flattened, about as wide as long, weakly bilobed; with weak carapace regional definition; marginal rim well-developed, wide, with posterior notch, with tiny marginal serrations; posterior axial keel present; rostral lobe extending beyond carapace, optic notches not well-developed; carapace with strongly, broadly spaced papillae posteriorly and laterally; first antennae strong, thick, with long flagella; second antennae slender, shorter; two pairs of subchelate appendages with sickle-like dactyls extending anteriorly from ventral to rostral lobe; five pediform thoracic appendages posterior to subchelate appendages; caudal rami lanceolate, long, slender; sternal region with at least five visible, well-defined somites, ovate central sternal area present; possible abdomen with 2–4 somites (adapted from FELDMANN & SCHWEITZER, 2019, p. 8). *Middle Pennsylvanian (Moscovian)*: USA (Illinois). *Upper Pennsylvanian (Kasimovian)*: USA (Missouri).——FIG. 4, 1a–c. **Americlus americanus* (PACKARD), Moscovian, Illinois; a, MCP 507, carapace and appendages; b, FMNH PE21013, ventral surface with appendages; c, labeled drawing; scale bars = 5 mm (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 10.1, 10.2, 10.3).

Brittaniclus SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 267 [**Cyclus rankini* WOODWARD, 1868, p. 73, pl. 2, 2; OD]. Carapace flattened, wider than long, bilobed; moderate carapace regional definition; marginal rim well-developed, wide, with posterior notch, may have strong keel on margin of rim; posterior axial keel strong; lyrate keels may be present; median concentric keel strong; rostral lobe extending

beyond carapace, with optic notches, with one to three transverse crests; axial and lateral regions moderately defined; first antennae strong, thick, with three stout basal articles and long flagella; second antennae slender, shorter; first pair of visible non-antennal appendages short; followed by two pairs of subchelate appendages with sickle-like dactyls; five pediform thoracic appendages posterior to subchelate appendages; male gonopod present, interpreted as exopod of last thoracic appendage; caudal rami present; sternal region with seven or eight visible, well-defined somites, ovate central sternal area; abdomen with 2–4 somites (modified from SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 267). *Middle Mississippian (Visean)*: UK (Scotland). *Upper Mississippian (Serpukhovian)*: UK (Scotland). *Middle Pennsylvanian (Moscovian)*: UK (England).——FIG. 4, 2a–c. **Brittaniclus rankini* (WOODWARD), Serpukhovian, Scotland; a, GLAHM A2811, carapace and appendages; b, labeled drawing of dorsal surface; c, labeled drawing of ventral surface; scale bar = 5 mm (adapted from CLARK & OTHERS, 2020, fig. 4A, 8A, 8B).

Dziklus SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 270 [**Cyclus obesus* SCHRAM, VONK, & HOF, 1997, p. 271, fig. 9, 10; OD]. Carapace much wider than long, rostral lobe wide, with straight anterior margin; marginal rim wide, continuous with no posterior notch, with short transverse keel anteriorly; median concentric keel continuous, forming a semicircular keel extending posteriorly; posterior axial keel absent; proximal elements of first antennae preserved (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 270). *Middle Pennsylvanian (Moscovian)*: USA (Illinois).——FIG. 5, 1a–c. **Dziklus obesus* (SCHRAM, VONK, & HOF), Moscovian, Illinois; a, FMNH PE 30630, holotype; b, labeled drawing of dorsal carapace; c, FMNH PE 34880, ventral surface; scale bars = 5 mm (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 12).

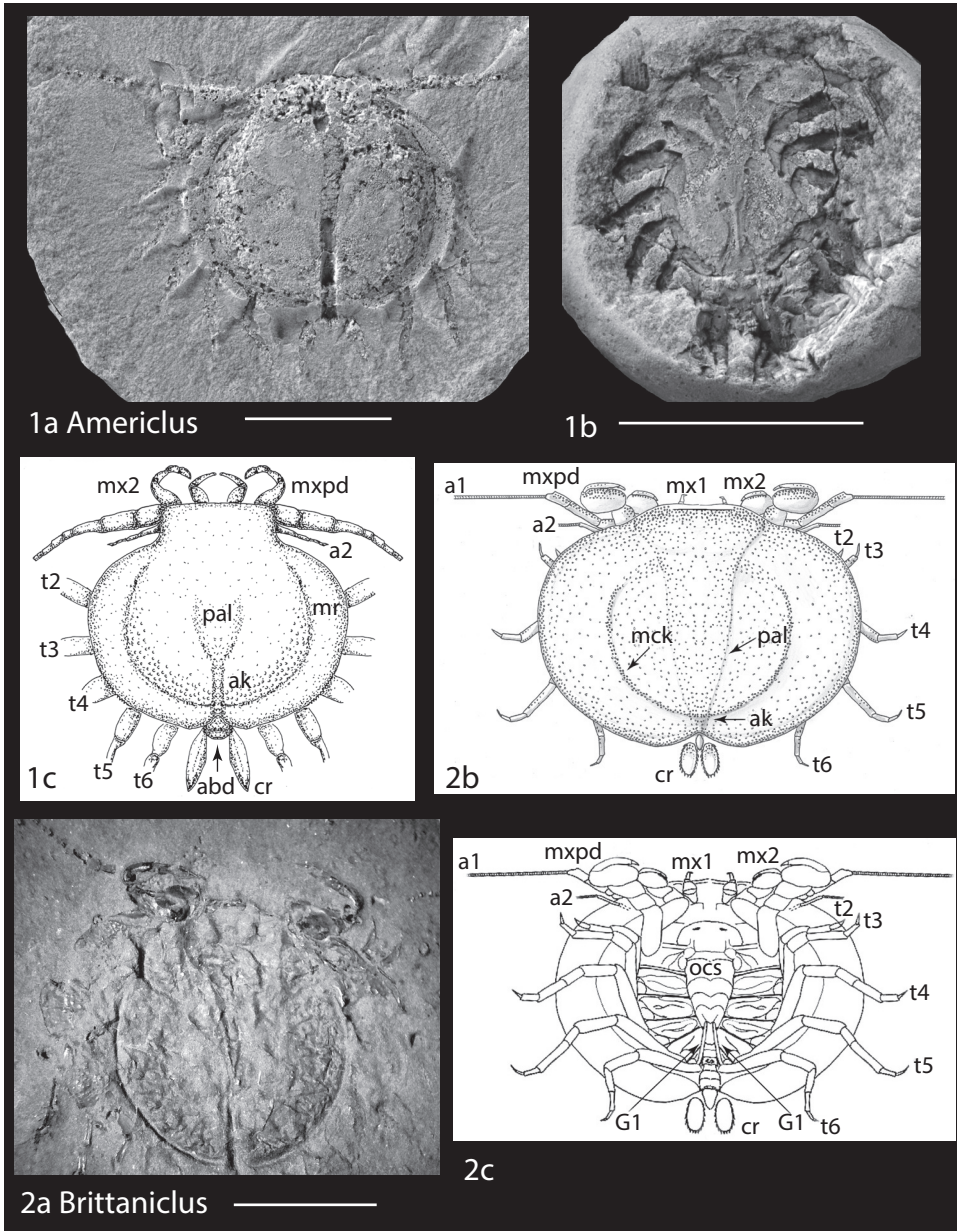


FIG. 4. Americlidae.

Malayacyclus TANG & OTHERS, 2023, p. 439 [**M. terengganuensis*, p. 440; OD] [non *Malayacyclus* TANG & OTHERS, 2021, unavailable name]. Carapace large, bilaterally symmetrical, slightly vaulted, surface strongly granular; rostrum extended anteriorly, optical notches just posterior

to rostrum; anterior lobes well-defined; posterior axial keel strong; inner lyrate keels well-defined, wide median concentric keel disappearing posteriorly; marginal rim granular, posterior margin with three spines and two posterior notches (adapted from TANG & OTHERS, 2021). *Middle*

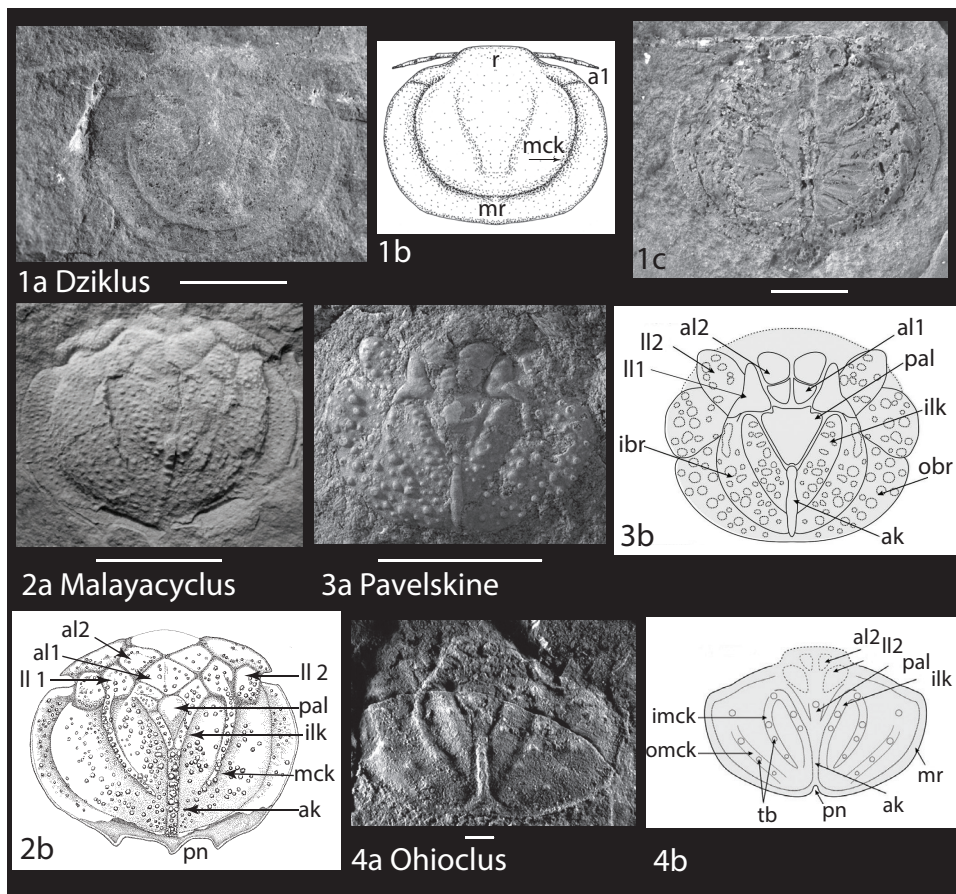


FIG. 5. Americulidae.

Mississippian (Visean): Malaysia.——FIG. 5, 2a–b. **M. terengganuensis*, a, UMF10942, holotype, Visean, Malaysia; b, labeled drawing of dorsal carapace; scale bar = 5 mm (adapted from TANG & OTHERS, 2021, fig. 4, 5a).

Ohioclus SCHWEITZER, MYCHKO, & LEHNERT, 2025, p. 2, fig. 2 [**O. columbianensis*; OD]. Carapace with two median concentric keels spaced equidistant from inner lyrate keel and marginal rim, keels ornamented with tubercles (SCHWEITZER, MYCHKO, & LEHNERT, 2025, p. 2). *Upper Pennsylvanian (Kasimovian)*: USA (Ohio).——FIG. 5, 4a–b. **O. columbianensis*, FMNH PE 60499, holotype, Kasimovian, Ohio; a, dorsal carapace; b, labeled

drawing of carapace; scale bar = 1 mm (adapted from SCHWEITZER, MYCHKO, & LEHNERT, 2025, fig. 2A, 5A).

Pavelskine SCHWEITZER, MYCHKO, & LEHNERT, 2025, p. 4 [**Cyclus packardii* ROGERS, 1902, p. 271, pl. 14,2; OD]. Carapace with large, widely spaced tubercles over most regions; first axial lobe rectangular, with three transverse ridges interrupted axially by groove, yielding a corrugated appearance; first lateral lobes longitudinally reniform, with distinctive arcuate, pointed extension at outer posterolateral corner, extension keeled; posterior notch and marginal rim absent (SCHWEITZER, MYCHKO, & LEHNERT, 2025, p. 4). *Upper Pennsylvanian (Kasimovian)*: USA (Kansas,

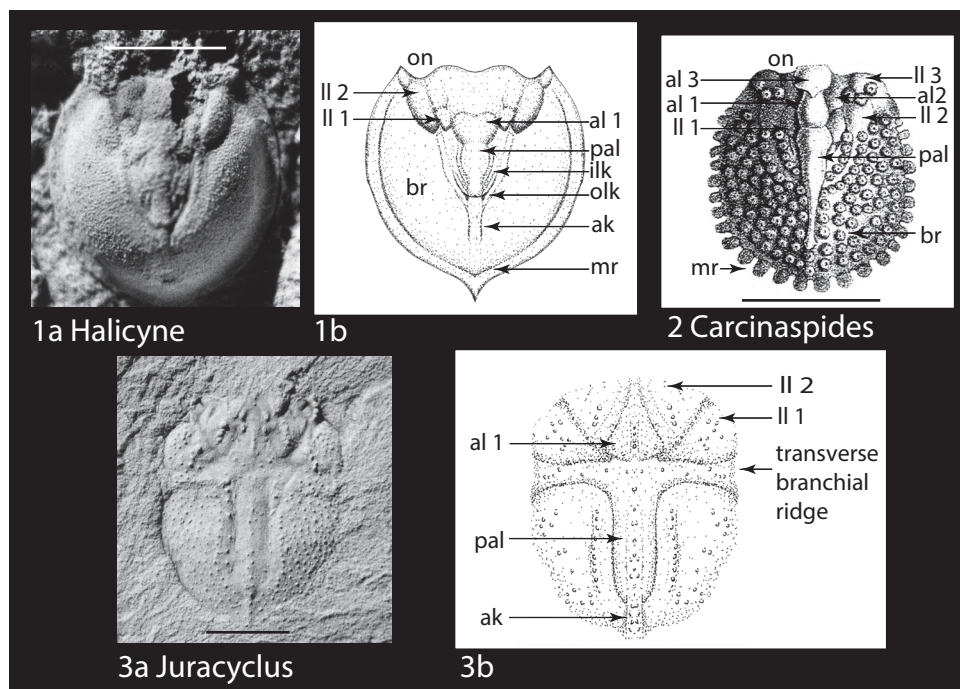


FIG. 6. Halicynidae.

Missouri).—FIG. 5, 3a-b. **Pavelskine packardi* (ROGERS), a, FMNH PE 93494, Kasimovian, Kansas; b, labeled drawing of carapace; scale bar = 5 mm (adapted from SCHWEITZER, MYCHKO, & LEHNERT, 2025, fig. 3A, 5B).

Family HALICYNIDAE Gall & Grauvogel, 1967

[*nom. correct.* DZIK, 2008, p. 1517, *pro* Halicynae GALL & GRAUVOGEL, 1967, p. 13]

Carapace ovate, generally narrowing posteriorly and nearly straight anteriorly; pedunculate eyes generally situated in shallow orbital notches on either side of a frontal or rostral area which may be lobate; antennae well-developed; carapace moderately inflated, with regionalization anteriorly and axially, posterior axial region ovate, extending into weak axial keel; marginal rim entire or lobate; at least five non-antennal appendages, with sickle-shaped dactyls; gills lamel-

late (modified after GALL & GRAUVOGEL, 1967; SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 271). *Lower Triassic (Olenekian)*–*Lower Jurassic (Toarcian)*.

Halicyne VON MEYER, 1844, p. 567 [**Limulus agnotus* VON MEYER, 1838, p. 415; M] [= *Halicyne laxa* VON MEYER, 1844, p. 567]. Carapace ovate, width about equal to length, flattened, straight anteriorly and narrowing posteriorly; shallow optic notches on either side of rostrum; one pair of axial lobes and two pairs of lateral lobes; posterior axial lobe and posterior axial keel well-developed; inner and outer lyrate keels thin; branchial regions large; marginal rim wide, entire; at least five non-antennal appendages with sickle-shaped dactyls; gills lamellate (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 272; MYCHKO, 2025, p. 4). *Lower Triassic (Olenekian)*: Germany, Russia. *Middle Triassic (Anisian)*: France, Germany, Netherlands, Poland. *Ladinian*: Germany, Italy, Switzerland.—FIG. 6, 1a–b. **Hali-*

cyne agnota (VON MEYER), SMNS 22152, holotype, Ladinian, Germany; *a*, dorsal carapace; *b*, labeled drawing; scale bar = 5 mm (photo by G. SCHWEIGERT; adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 13.1,13.2).

Carcinaspides GLAESSNER, 1969, p. R569 [**Carcinaspis pustulosa* SCHAFFHÄUTL, 1863, p. 423, pl. 74; OD] [replacement name for *Carcinaspis* SCHAFFHÄUTL, 1863, p. 423, junior homonym of *Carcinaspis* STIMPSON, 1858, p. 161 (Crustacea)]. Carapace ovate, front straight, possibly with weak concavities for orbits; axial regions well-defined, with posterior axial and all three axial lobes and all three pairs of lateral lobes defined; margin rimmed, rim with wide, quadrate teeth; branchial regions ornamented with arcuate, parallel rows of large tubercles (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 277). *Middle Triassic (Ladinian)*: Germany.—FIG. 6,2. **Carcinaspides pustulosus* (SCHAFFHÄUTL), drawing from SCHAFFHÄUTL (1863, pl. 74,16*b*) (holotype considered as lost, SCHWEITZER, MYCHKO, & FELDMANN, 2020); scale bar = 1 cm (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 14).

Juracyclus SCHWEIGERT, 2007, p. 214, fig. 1.1 [**J. posidoniae*; OD]. Carapace margins unknown; anterior lobe 1 and lateral lobes 1 and 2 moderately inflated, ornamented with rows of tubercles and scattered tubercles; transverse branchial ridge well-defined; posterior axial lobe and axial keel confluent, with axial row of granules; branchial regions with evenly spaced granules (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 277). *Lower Jurassic (Toarcian)*: Germany.—FIG. 6,3*a–b*. **J. posidoniae*, SMNS 65488, holotype, Toarcian, Germany; *a*, dorsal carapace; *b*, labeled drawing; scale bar = 5 mm (photo by G. Schweigert; adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 15).

Family HEMITROCHISCIDAE Trauth, 1918

[Hemitrochiscidae TRAUTH, 1918, p. 180]

Carapace ovate, strongly vaulted, usually with an overall straight front and rounded posterior margin; orbital notches set laterally, rounded, eyes apparently protruding from orbit; carapace margins usually ornamented, either with spines or strong tubercles; carapace surface with regularly spaced granules, tubercles, or ridges; carapace regions weakly defined. Ventral surface of carapace with evidence of thoracic segmentation, sometimes with broad serrations; inner surface of lateral margins with thoracic segmentation. No appendages are known (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 278). *Upper Pennsylvanian (Gzhelian)–Upper Triassic (Carnian)*.

Hemitrochiscus SCHAUROTH, 1854, p. 558, pl. 22,1 [**H. paradoxus*; M]. Carapace semi-circular, strongly domed, optic notches deep; vermiform lines on postero-lateral margins of carapace; thoracic somites visible ventrally and laterally where carapace is broken (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 278). *Permian (Lopingian)*: Germany.—FIG. 7,1*a–c*. **H. paradoxus*, NMC 1648, syntype, Lopingian, Germany; *a*, dorsal surface; *b*, ventral surface; *c*, labeled drawing; scale bars = 1 mm (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 16).

Cyclocarcinides GLAESSNER, 1969, p. R569 [**Cyclocarcinus serratus* Stolley, 1915, p. 676, pl. 40,1, 2; M] [replacement name for *Cyclocarcinus* STOLLEY, 1915, p. 676; *non Cyclocarcinus* GUÉRIN-MÉNEVILLE, 1838, p. 12 (Crustacea)]. Carapace circular or ovate, strongly domed; orbits positioned 20–33% of the distance posteriorly on carapace; surface uniformly granular or with reticulate, stellate, or linear ornamentation; carapace lobes or other regions not defined; marginal rim strong, divided into sharp triangular spines (adapted from SCHWEITZER, MYCHKO,

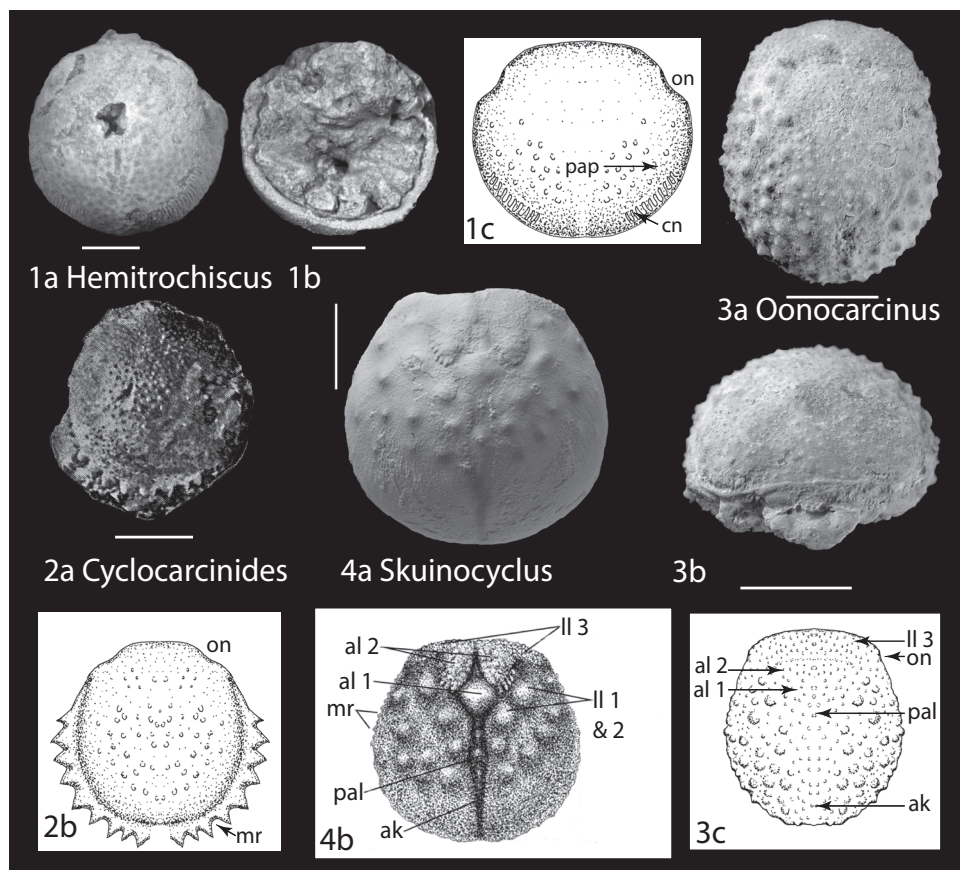


FIG. 7. Hemitrochiscidae.

& FELDMANN, 2020, p. 280). *Upper Triassic (Carnian)*: Austria, Bosnia and Herzegovina, Slovakia.—FIG. 7, 2a-b. **Cyclocarcinides serratus* (STOLLEY), Carnian, Austria; a, original figure of STOLLEY (1915, pl. 40, 1); b, labeled drawing; scale bar approximately 5 mm (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 17.1, 17.2).

Oonocarcinus GEMMELLARO, 1890, p. 24 [**O. insignis* GEMMELLARO, 1890, p. 26, pl. 3, figs. 3–13; SD GLAESSNER, 1969, p. R569; = *O. anceps* GEMMELLARO, 1890, p. 28; *O. geinitzi* GEMMELLARO, 1890, p. 27]. Carapace longitudinally ovate, very strongly domed; optic notches placed laterally; labrum extending anteriorly from frontal margin; carapace regions poorly defined, posterior axial keel very weak; surface granular and

with large spinose tubercles (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 283). *Upper Pennsylvanian (Gzhelian)–Permian (Cisuralian, Asselian)*: Russia. *Permian (Guadalupian, Wordian)*: Italy. *Upper Triassic (Carnian)*: Slovakia.—FIG. 7, 3a–c. **O. insignis*, specimen illustrated as pl. 3, fig. 6 of GEMMELLARO (1890), Wordian, Italy; a, dorsal carapace; b, anterior view showing labrum; c, labeled drawing; scale bars = 1 cm (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 18.1–18.3).

Skuinocyclus MYCHKO & ALEKSEEV, 2018, p. 29, fig. 4, 5 [**S. juliae*; OD]. Carapace bilaterally symmetrical, hemispherical, strongly vaulted; carapace margin rimmed by two parallel rings of granular ridges; median groove posteriorly; posterior axial

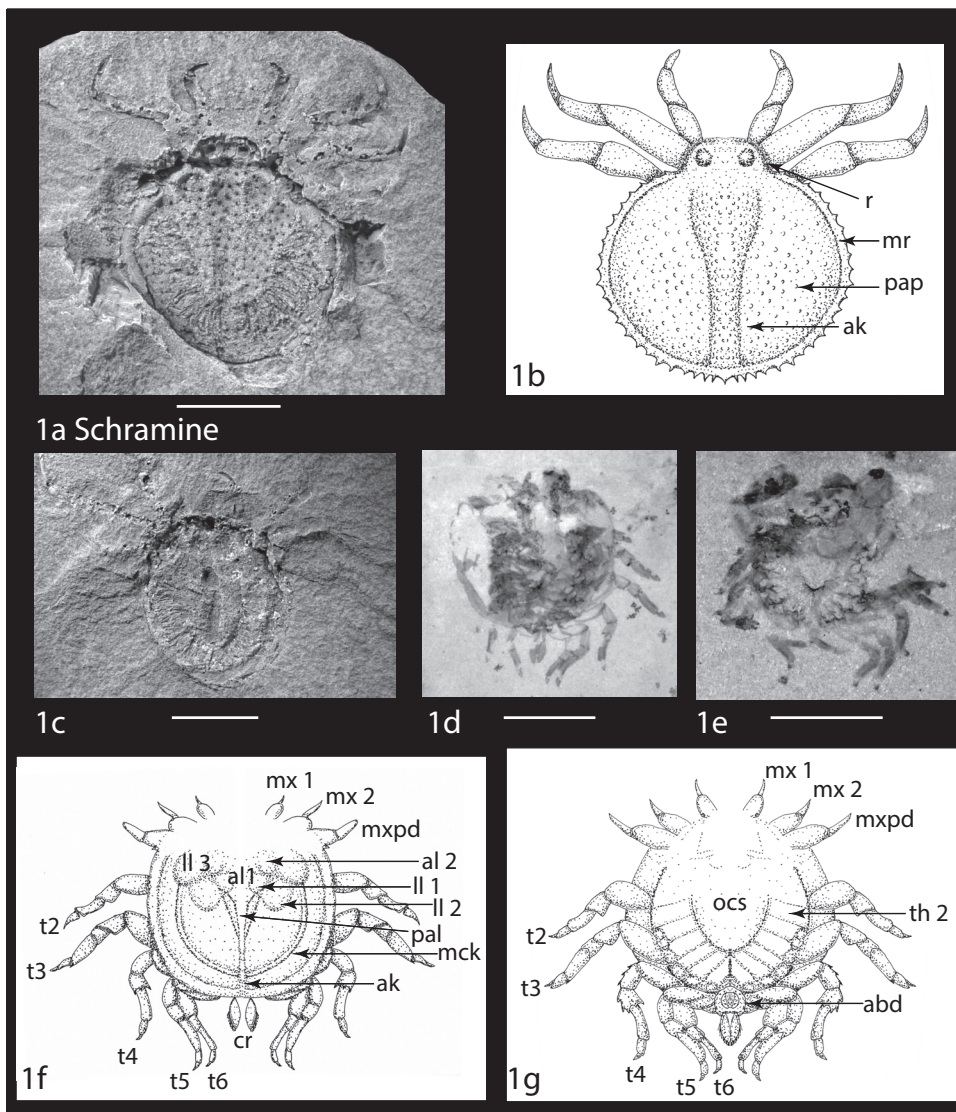


FIG. 8. Schramminidae.

lobe, anterior lobes 1 and 2, and lateral lobes 1–3 all weakly developed, lateral lobe three densely granular; branchial regions with scattered large tubercles (adapted from MYCHKO & ALEKSEEV, 2018). *Permian (Cisuralian, Asselian-Sakmarian)*: Russia. —FIG. 7, 4a–b. **S. juliae*, PIN 5610/1, holotype, Asselian, Russia; a, dorsal carapace; b, labeled drawing; scale bar = 1 cm (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 20).

Family SCHRAMMINIDAE Dzik, 2008

[Schramminidae DZIK, 2008, p. 1517]

Carapace overall circular, usually with rostral lobe well produced anteriorly and with optic notches at bases; carapace regional development only axial, axial keel may extend nearly entire length of carapace; carapace margins entire or serrate; carapace ornamentation strongly or densely granular either

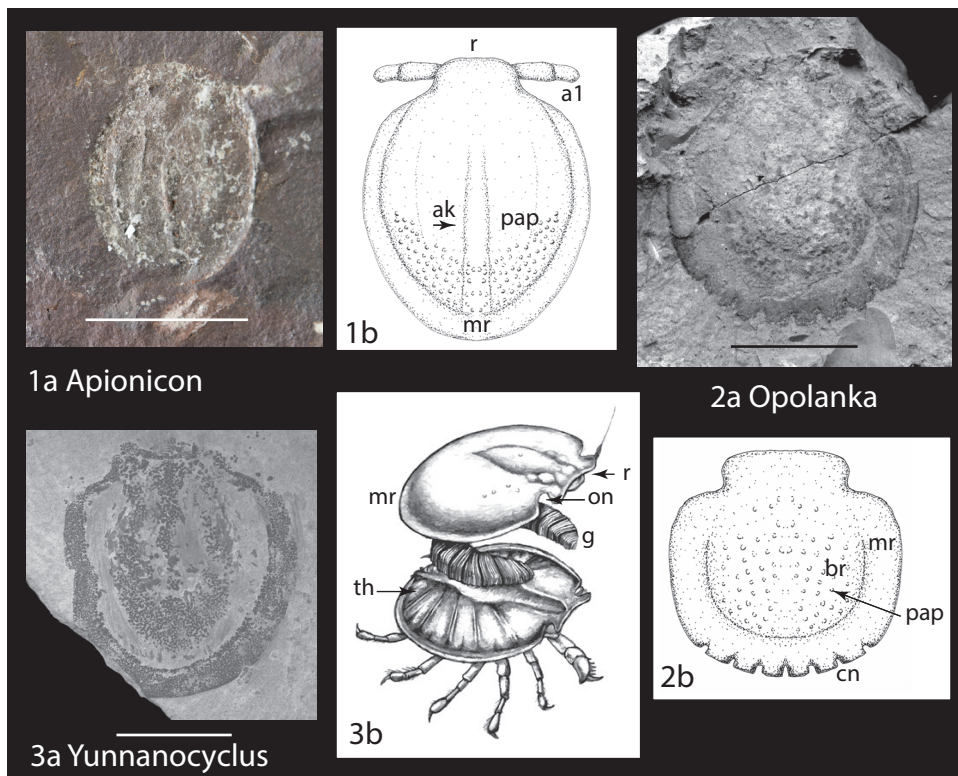


FIG. 9. Schramminidae.

marginally or overall; at least six appendages, anterior-most with sickle-shaped dactyls; caudal furcae extending posteriorly; at least six thoracomeres expressed ventrally; gills lamellate, arranged in a horseshoe-shaped array (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 286). *Upper Mississippian (Serpukhovian)*—*Upper Triassic (Carnian)*.

Schramine DZIK, 2008, p. 1517 [**Halicyne max* SCHRAM, VONK, & HOF, 1997, p. 273, fig. 11–16; OD]. Carapace almost circular in outline, slightly vaulted in cross section, bearing distinct strong papillose ornamentation; marginal rim narrow, with tiny marginal quadrate projections; axial regions well-defined; rostral lobe extending strongly anteriorly; anterior-most appendages with sickle-shaped dactyls, dactyls directed forward (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 286). *Upper Mississippian (Serpukhovian)*: USA (Montana). *Middle*

Pennsylvanian (Moscovian): USA (Illinois). *Lower Triassic (Olenekian)*: Madagascar.—FIG. 8, 1a–c. **Schramine max* (SCHRAM, VONK, & HOF); a, FMNH PE 34772, holotype, Moscovian, Illinois; b, labeled drawing; c, FMNH PE 25662, Moscovian, Illinois, carapace, appendages, and gills; scale bars = 5 mm (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 21.1–3).—FIG. 8, 1d–g. *Schramine montanaensis* (SCHRAM, BOERE, & THOMAS, 2006), Serpukhovian, Montana; d, UMPC 206106a, ventral view; e, UMPC 206106b, ventral view; f, labeled drawing of dorsal view; g, labeled drawing of ventral view; scale bars = 5 mm (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 22.3–6).

Apionicon SCHRAM, VONK, & HOF, 1997, p. 277, fig. 15.4, 17, 18 [**A. apioides*; OD]. Carapace longer than wide, longitudinally ovate, with axial keel running entire length

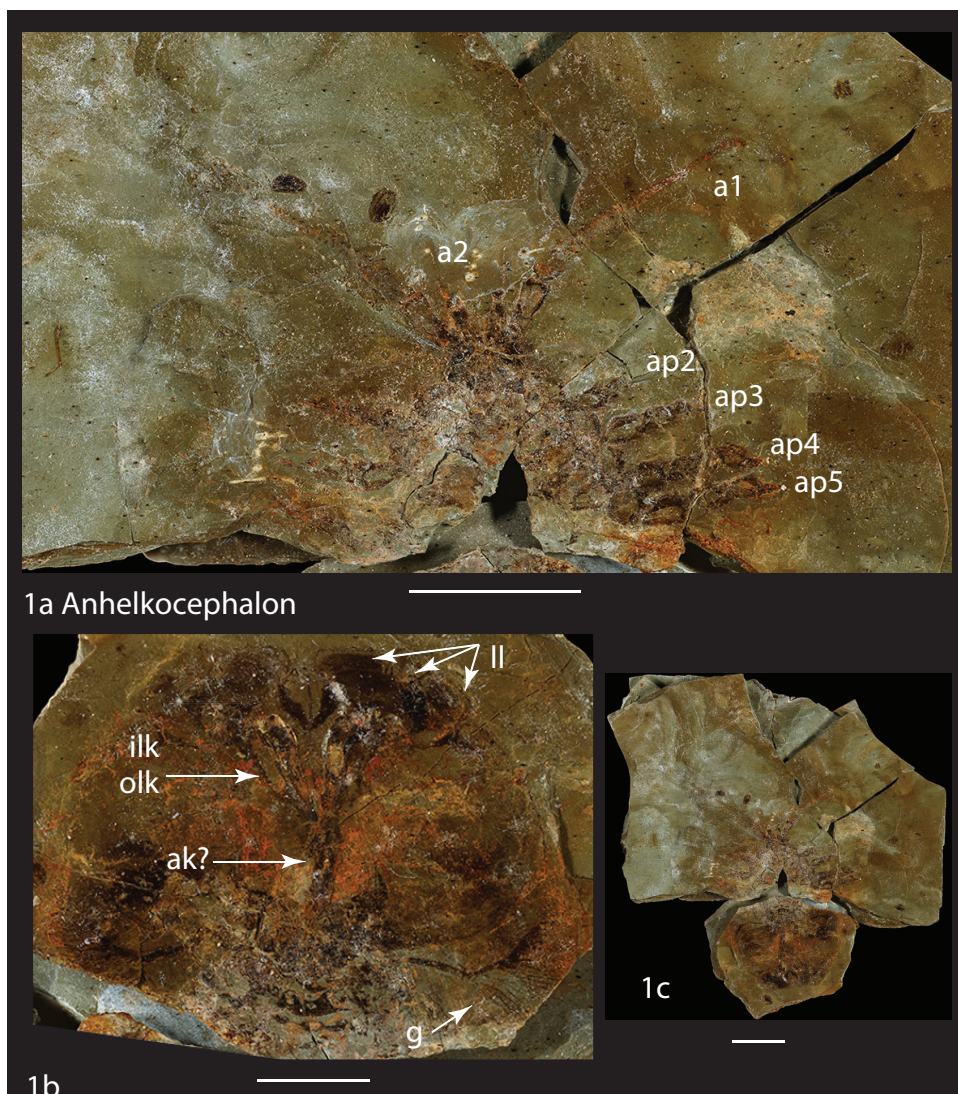


FIG. 10. Cyclida family incertae sedis.

of carapace; coarse tubercles ornamenting lateral-most branchial regions and posterior one-quarter of carapace; marginal rim wide, narrowing anteriorly, edge with tiny corrugations (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 291). *Middle Pennsylvanian (Moscovian)*: USA (Illinois).—FIG. 9, 1a–b. **A. apioides*, FMNH PE 22464, holotype, Moscovian, Illinois; *a*, dorsal view; *b*, labeled drawing; scale bar = 5 mm (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 23).

Opolanka DZIK, 2008, p. 1517, fig. 1, 2, 4–6 [*O. decorosa*; OD]. Carapace ovate, with coarse, widely dispersed papillae; marginal rim wide, flattened, crenulated posteriorly, with six or so lobes; circular depression appearing to be located at about one-third the distance laterally on the marginal rim; branchial regions appearing to be undifferentiated; gill lamellae well developed on some specimens (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, p. 292). *Upper Triassic (Carnian)*:

Poland.—FIG. 9,2*a-b*. **O. decorosa*, ZPAL Ab III/1363, holotype, Carnian, Poland; *a*, dorsal carapace; *b*, labeled drawing; scale bar = 1 cm (photo by J. Dzik; adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 24).

Yunnanocyclus FELDMANN, SCHWEITZER, & HU *in* FELDMANN & OTHERS, 2017, p. 408, fig. 2–4 [**Y. nodosus*; OD]. Rostral lobe straight; optic notches shallow; marginal rim complete, separated from carapace shield by concentric depression; surface of carapace uniformly nodular; ventral surface with circular buccal cavity, with seven concave-forward thoracomeres; gills lamellate; mandibles strongly mineralized (adapted from FELDMANN & OTHERS, 2017). *Early Triassic (Induan)*: China. *Middle Triassic (Anisian)*: China.—FIG. 9,3*a-b*. **Y. nodosus*, LPI 33886, holotype, Anisian, China; *a*, dorsal carapace; *b*, labeled drawing (drawing by E. Maguire); scale bar = 1 cm (adapted from SCHWEITZER, MYCHKO, & FELDMANN, 2020, fig. 25).

Family incertae sedis

Anhelkocephalon BILL, 1914, p. 338 [**A. handlirschi*; M]. Carapace circular; inner and outer lyrate keels and posterior axial keel well-developed; antennae longer and stouter than antennules, antennae with three peduncular segments and long flagellum; at least four non-antennal appendages; carapace apparently with lines or sutures forming polygons (based upon neotype illustrated by SCHÄDEL & HAUG, 2020, p. 72, fig. 2). *Middle Triassic (Anisian)*: France.—FIG. 10,1*a-c*. **A. handlirschi*, SMNS 75641-1, neotype; *a*, anterior part of body with appendages; *b*, dorsal carapace; *c*, entire specimen (note carapace is upside down); scale bars *a* and *c* = 1 cm; scale bar *b* = 5 mm (new, photo provided by M. Schädel, labels following SCHÄDEL & HAUG, 2020, fig. 2).

ABBREVIATIONS FOR MUSEUM REPOSITORIES

- AMNH**: American Museum of Natural History, New York, New York, USA
FMM: Fossa Magna Museum, Itoigawa, Niigata, Japan
FMNH: Field Museum of Natural History, Chicago, Illinois, USA
GLAHM: Hunterian Museum, University of Glasgow, Scotland, UK
GSM: Geological Survey Museum, British Geological Survey, Keyworth, England, UK
LPI: Invertebrate Paleontology Collection, Chengdu Institute of Geology and Mineral Resources, Chengdu, Sichuan Province, China
MAB k.: Oertijdmuseum, Boxtel, The Netherlands
MCP: Mazon Creek Project, Northeastern Illinois University, Northfield, Illinois, USA
MGSB: Museu Geològic del Seminari de Barcelona, Spain
MM: Manchester Museum, University of Manchester, England, UK
NHMUK: The Natural History Museum, London, England, UK
NMC: Naturkunde-Museum Coburg, Germany
PIN: Borissiak Paleontological Institute, Russian Academy of Sciences, Moscow, Russia
SM: Sedgwick Museum of Earth Sciences, Cambridge University, England, UK
SMNS: Staatliches Museum für Naturkunde, Stuttgart, Germany
TsNIGR: Academician F.N. Chernyshev Central Research Geological Exploration Museum, St. Petersburg, Russia
UMF: Department of Geology, Universiti Malaya, Kuala Lumpur, Malaysia
UMPC: University of Montana Paleontology Center, Missoula, Montana, USA
ZPAL: Institute of Paleobiology, Polish Academy of Sciences, Warsaw, Poland

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