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(PALEOCENE) OF NORTH DAKOTA

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CRABS FROM THE CANNONBALL FORMATION (PALEOCENE) OF NORTH DAKOTA¹

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ABSTRACT—More than 50 specimens of fossil crabs collected from the Cannonball formation (Paleocene) of southern Morton and Burleigh Counties, south-central North Dakota form the basis for the first report of fossil crustaceans in North Dakota. The new genus *Camarocarcinus* is created for their reception with the new species *C. arnesoni* as the type species. A separate, single, large propodus is placed in a new species, *Ranina* (?) *burleighensis*, by the senior author. The mode of occurrence suggests a near-shore condition of the Cannonball sea in this part of North Dakota.

INTRODUCTION

THE rarity of fossil decapod crustaceans in the northern Midcontinent makes the recent discovery of over 50 specimens of well preserved fossil crabs in the Cannonball formation of south-central North Dakota the more interesting. These are the first fossil crabs to be found in North Dakota, and prior to this find only six

species in as many genera were known from this general area (Rathbun, 1935). The following decapods have previously been reported by her from the northern Midcontinent:

South Dakota

Pierre Shale:

Dakoticancer overana Rathbun; west side Missouri River, in Corson Co. a short distance south of Moberly; and along Indian Creek, Pennington Co.

Necrocarcinus pierrensis Rathbun; eastern Corson Co.

Homolopsis punctata Rathbun; eastern Corson Co.

Callianassa cheyennensis Rathbun; both banks of Missouri River between the Cheyenne

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EXPLANATION OF PLATE 74

All figures $\times 1$

FIGS. 1-14—*Camarocarcinus arnesoni* Holland & Cavanaugh, n. gen., n. sp., Cannonball formation, Paleocene, Locality No. 1, southern Burleigh County, North Dakota. All specimens believed to be female. **1,2**—Respectively outer and inner views of right manus with carpus attached at nearly right angle to observer; dactylus and pollex missing. Paratype, UND No. 574. **3,4**—Respectively outer and inner views of broken left propodus of paratype, UND No. 573. **5**—Ventral surface showing inflated pterygostomium with rim (near right exognath), third maxilliped with left endognath pushed under curved exognath, broken merus, carpus, and propodus with partial pollex and dactylus of right cheliped rotated posteriorly 180° out of natural position, and stubs of two ambulatory legs of left side. Paratype, UND No. 573. **6**—Left lateral view of crushed specimen to illustrate the rostrum. Hypotype, UND No. 705. **7-11**—Respectively dorsal, anterior, ventral, posterior, and right lateral views of holotype, U. S. Natl. Mus. No. 562093. Dark irregular spaced marks especially evident in Figs. 7 and 8 are pocking of the exoskeleton by weathering. Fig. 9 shows the distally broken right manus and complete carpus on viewer's left; near the posterior the left ischiobasis, merus, and propodus are shown. Fig. 10 shows a portion of the carpus articulated with the propodus of the left cheliped. Fig. 11 shows the rostrum to the viewer's right and the broken rim of the carapace just below the large lateral spine bases. **12,13**—Dorsal and ventral views respectively of large, fractured specimen. Paratype, UND No. 572. **14**—Dorsal view of badly broken specimen showing long, curved right fourth lateral spine. Paratype, UND No. 571.

15—*Ranina* (?) *burleighensis* Holland, n. sp., Cannonball formation, Paleocene, Locality No. 1, southern Burleigh County, North Dakota. Outer view of left propodus showing broken dactylus and stub of pollex. Holotype, U. S. Natl. Mus. No. 562094.

River and the North Dakota-South Dakota line.

Niobrara formation:

Linuparus canadensis (Whiteaves); head of Cottonwood Creek, Meade Co.

Carlisle shale:

Linuparus canadensis (Whiteaves); near White-wood, Lawrence Co.

Wyoming

Lewis shale:

Tetracarcinus subquadratus Weller; on U. S. Highway 30, 8 miles west of Rawlins, Carbon Co.

All of these species are from the Upper Cretaceous; and except for *Dakoticancer overana*, which is represented by more than 80 specimens in the original collection (Rathbun, 1917), each is known from only one or two specimens from this area. In addition *Necrocarcinus pierrensis* and *Tetracarcinus subquadratus* are known from New Jersey, *Dakoticancer overana* from New Jersey and Tennessee, and *Linuparus canadensis* has been taken from the Benton group of Alberta and identified by Rathbun from the Ripley formation of Tennessee and Louisiana. The collection of fossil crabs at hand, then, is the first known to the writers from the Tertiary of the north-central States and the Prairie Provinces.

Mr. William W. Arneson (now geologist, Northwest Geological Service, Billings, Montana, but then serving as Field Inspector and Geologist for the Conservation Division of the North Dakota Geological Survey) made the initial collection of eight rather complete carapaces, numerous fragments, and associated material in early November, 1954. During June, 1955, the writers visited the site of the original discovery numerous times and subsequently the site has been revisited several times by both Mr. Arneson and the senior author. The collection has been added to on each occasion until at this time it consists of over 50 well-preserved and fairly well-preserved carapaces, and numerous fragmental or badly weathered carapaces and separate partial pereopods.

The specimens collected are apparently heretofore undescribed and a new genus, *Camarcocarcinus* and two new species are created for their reception. The crustacean fauna of the Cannonball formation thus consists of:

Camarcocarcinus arnesoni Holland & Cavanaugh, n. gen., n. sp.

Ranina (?) *burleighensis* Holland, n. sp. (one specimen only).

Since the original discovery at Locality No. 1, below, crabs have been found by the writers at two additional localities in the Cannonball. Cannonball crab localities in North Dakota (Fig. 1) are:

Locality No. 1—Sand blow-out, west side of road, NE corner, Sec. 28, T. 137 N., R. 77 W., 5 miles west and 1.1 miles south from Moffit, southern Burleigh Co., North Dakota.

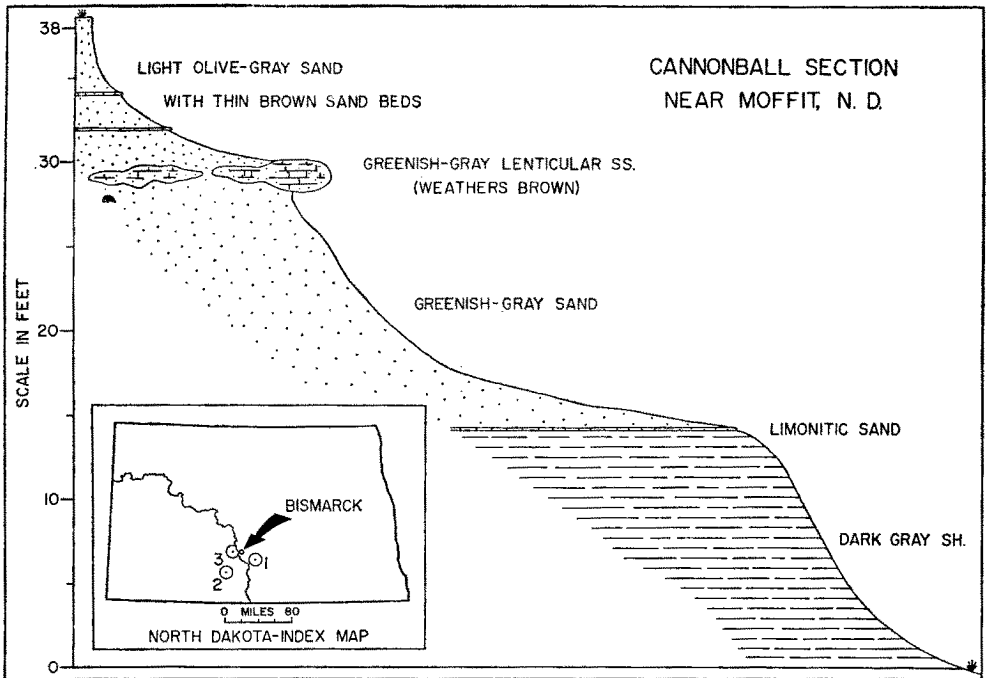
Locality No. 1a—Just south of crest of hill, curve in abandoned road east of new road, NW $\frac{1}{4}$ Sec. 28, T. 137 N., R. 77 W., 6 miles west and 1.1 miles south from Moffit, southern Burleigh Co., North Dakota.

Locality No. 2—South facing hillside, north of North Dakota highway 21, NW $\frac{1}{4}$ Sec. 4, T. 134 N., R. 83 W., about 5 miles east of Flasher, Morton Co., North Dakota.

At Locality No. 1 the crabs were found weathered out and lying loose on the surface, especially near the upper part of the exposed section, while at Localities 1a and 2 they were laboriously cracked from extremely hard sandstone nodules. At Locality No. 1a these nodules were strewn down the hill on the surface of the old road, but at Locality No. 2 the nodules were found loose in the grass below obscure sandstone outcrops.

Stratigraphy.—Maps by Lloyd and Hares (1915), Stanton (1920), Hansen (1952, 1956), and Benson (1951) show the areal extent of the Cannonball formation in North Dakota. Laird and Mitchell (1942) and Fisher (1952) have presented measured sections of the Cannonball in Morton County and in Emmons County (east of the Missouri River just south of Burleigh County); and for more details of the regional stratigraphy of the general area, the reader is referred to these publications. For faunal information on the Cannonball one should refer to papers by Stanton (1920), Vaughan (1920), Fox and Ross (1942), and Brown and Lemke (1948).

Localities 1 and 1a occur in an area shown on these maps as being the continental Hell Creek formation of Upper Cretaceous age. However the Cannonball seems to be more extensive east of the Missouri River than was previously suspected. East of the river



TEXT-FIG. 1.—Section of Paleocene Cannonball formation in road-ditch exposure, Locality No. 1, near Moffit, southern Burleigh County, North Dakota. This is the type locality of *Camarocarcinus arnesoni* Holland & Cvancara, n. gen. n. sp., and *Ranina* (?) *burleighensis* Holland, n. sp.; the crabs were found free, loose on the surface, mostly near the upper part (31 to 35 feet above base of measured section) of the exposure. The insert map shows the two principal areas where *Camarocarcinus* occurs (Locality 1a is only one mile west of Locality 1 and hence these two localities are covered by dot of No. 1).

in southern Burleigh and northern Emmons Counties the Cannonball comes to lie directly on the Hell Creek (Fisher, 1952, p. 20, 41), but in Morton County, west of the Missouri River, the continental facies equivalent of the Cannonball, the Ludlow formation, interfingers with it, and a tongue of the Ludlow reaches east to the bluffs of the Missouri below the Cannonball, separating it from the underlying Hell Creek (Laird and Mitchell, 1942, p. 18).

It is entirely possible that the claystone at the bottom of the exposed section is Hell Creek, for Hell Creek was found some 65 feet lower, one mile east and .9 mile south of this locality (SW $\frac{1}{4}$ Sec. 26, T. 137 N., R. 77 W.).

At Locality 1a the section is mostly covered but some light olive gray sand could be seen in gullies beside the old road (later

completely filled in when a new road was built during July 1956) north of the crest of the hill. At the very crest of the hill a three-inch sandstone very similar to that of the crab matrix occurs, but no crabs or crab-bearing nodules could be found in place.

At Locality 2 in Morton County nodules bearing crabs and crab fragments were rather common about the level of the sub-upland (Number 2) bench or middle Cannonball sand of Laird & Mitchell (1942, p. 19). The nodules are commonly three to four inches in diameter and subspherical or elongate with the general shape commonly controlled by vague harder sandstone "tubes" which traverse the interior of the nodule. These tubes (generally about one half inch in diameter) are irregular in their occurrence and architecture and seemingly have no direct connection with the crabs

SECTION MEASURED AT LOCALITY NO. 1
(Colors according to Goddard, et al., 1948)

	Feet
Sand dunes; grass	
Sand; light olive-gray (5Y 6/2), fine grained, subangular to angular, with occasional thin irregular beds of light brown (5YR 5/6) very fine grained, hard sandstone or moderate brown (5YR 3/4) fine grained, semiconsolidated sandstone.....	8.4
Sandstone; greenish gray (5GY 6/1), fine grained, subangular, calcareous, very hard lenticular; weathers moderate yellowish brown (10YR 6/4).....	2.0
Sand; light olive-gray (5Y 5/2) becoming slightly darker near base; fine grained to very fine grained, angular to subangular; few very thin limonitic, semiconsolidated sandstone beds and nodules; many vertical "worm" beds of yellowish gray sand near top; petrified wood bored by shipworms abundant on surface.....	13.9
Sand; limonitic semiconsolidated, containing small fragments of light olive gray shale.....	.2
Claystone; olive gray (5Y 4/1) to light olive gray (5Y 6/1), blocky, nonfissile, containing triturated plant material; few thin limonitic silt to very fine sand beds near top.....	14.1
Total exposed section.....	38.6

which occur in the nodules; their origin remains an enigma.

The lithology of the matrix covering the ventral surface of the crabs from Locality 1 and the lithology of the nodules which contain crabs at Localities 1a and 2 is so distinctive that the writers can ascertain almost every time which nodules will contain a carapace or crab fragments. At another locality (herein called Locality No. 3) the writers, however, found nodules believed identical to those of Localities 1a and 2 but could find no crabs.³ Locality No. 3 is:

Top of road cut, north side U. S. highway 10, SE $\frac{1}{4}$ Sec. 23, T. 139 N., R. 82 W., 4.65 miles west of railway station, center of Mandan, Morton County.

The junior author made a quantitative petrographic study of the nodules with the results shown in Table 1 (percentages estimated with the use of charts in Spock, 1953, p. 28-31).

The matrix of the crabs at Locality 1a might thus be more exactly designated a grayish brown (5YR 4/2) phosphatic feldspathic arenite, and the nodules from the other localities would be phosphatic

ubfeldspathic lithic arenites (according to the terminology of Williams, Turner, and Gilbert, 1955). The cement of all of the nodules seems to be colophane and dahllite.

Associated with the crabs at Locality 1 were the following fossils: Abundant petrified wood much of it bored by a *Mariestia*-like pelecypod, *Lamna cuspidata* Agassiz (shark teeth), and shark (?) vertebrae. A small *Protocardia*-like pelecypod was found in a nodule at Locality 1a. Tiny gastropods (? *Drepanochilus* sp.) were found in a nodule at Locality 3; fish scales and bones, fossil wood, pelecypods (*Lucina cedrensis* Stanton and *Trigonocallista* sp.) and gastropods were found in a similar rock on Mitchell Butte, two miles southwest of Locality 2, although crabs were not found on Mitchell Butte.

Paleoecology.—The writers envision a shallow epicontinental sea (although not as restricted as formerly thought, Brown and Lemke, 1948, and Hansen, 1956) and a mild climate in central North Dakota in early Paleocene time. It is believed that *Camarocarcinus* inhabited the littoral or epineritic zone and burrowed in the sand as described

TABLE 1—PERCENTAGES OF VARIOUS COMPONENTS IN CANNONBALL SANDSTONE NODULES

Locality	Feldspar	Quartz	Cement	Rock fragments	Other Minerals	Void pores
1a	15%	20%	43%	12%	4%	6%
2	15%	15%	40%	23%	3%	4%
3	10%	20%	35%	21%	4%	10%

³ Since the manuscript for this paper was prepared, Mr. Arneson has found nodules of "crab lithology" containing fragments of *Camarocarcinus* in a roadcut on the south side of U. S. highway 10 about one mile west of Locality 3 on a hillside at the same level as Locality 3. Thus, following the discovery of nodules of this distinctive lithology and futile search for crabs by the writers, the prediction that crabs would be found in the vicinity has been borne out. This locality (designated Locality 3a) makes the fourth site from which *Camarocarcinus* has been collected.

by Bourne (1922) for many of the Raninidae. How efficient a digger was *Camarocarcinus* can not be estimated, for the distal portions of the posterior pereopods are unknown. Since the body of this form is not as elongated as many of the raninids, it may not have lain deeply buried but may have been adept at natation. In any event, shifting sands may have overwhelmed many of the crabs in their burrows, for it is believed that most of the crabs were not washed about as empty carapaces so perfect is the preservation. The association with large logs of fossil wood, the abundant borings in the wood, the sharks' teeth and bone fragments, and the absence of normal marine shells, even the very appearance of the outcrop at Locality 1, suggests an ancient beach with its scattered driftwood, sand bars, and polished pebbles.

Acknowledgments.—The writers are indebted to many people for aid during the preparation of this paper. To these people we extend our grateful thanks. We are especially indebted to William Arneson for his geological alertness in discovering these unusual fossils in an inauspicious looking sand blow-out while working in a different capacity for the State Geological Survey. He recognized the type of animal represented, and, realizing their relative rarity and value, has generously presented his entire collection to the Geology Department, University of North Dakota. We wish to thank Dr. Wilson M. Laird, State Geologist of North Dakota, for providing the opportunity and facilities for field and laboratory study in connection with this description. Dr. H. B. Stenzel of Houston, Texas, and Dr. Fenner A. Chace, Jr., U. S. National Museum, have been kind enough to criticize the manuscript and offer many helpful suggestions. Miss Caroline G. Lybeck, Assistant Librarian of the University of North Dakota, has been most co-operative throughout the study. Dr. D. J. Georgacas, Department of Modern and Classical Languages, University of North Dakota, graciously assisted the writers with the etymology of the names involved. Messrs. R. G. Monroe and E. E. Wilson aided the writers in the field. Dr. and Mrs. G. C. Wheeler, Biology Department, University of North Dakota, and son, Ralph,

have donated specimens collected by them and have maintained an enthusiastic interest in the study.

SYSTEMATIC PALEONTOLOGY

Phylum ARTHROPODA Siebold & Stannius, 1845

Class CRUSTACEA Pennant, 1777

Order DECAPODA Latreille, 1802

Suborder HETEROCHELIDA Beurlen & Glaessner, 1931

Tribe BRACHYURIDEA Glaessner, 1929

Superfamily GYMNOPLEURA Bourne, 1922

Family RANINIDAE Dana, 1849

Genus CAMAROCARCINUS, n. gen.

Type species.—*Camarocarcinus arnesoni* Holland & Cvancara, sp. nov.

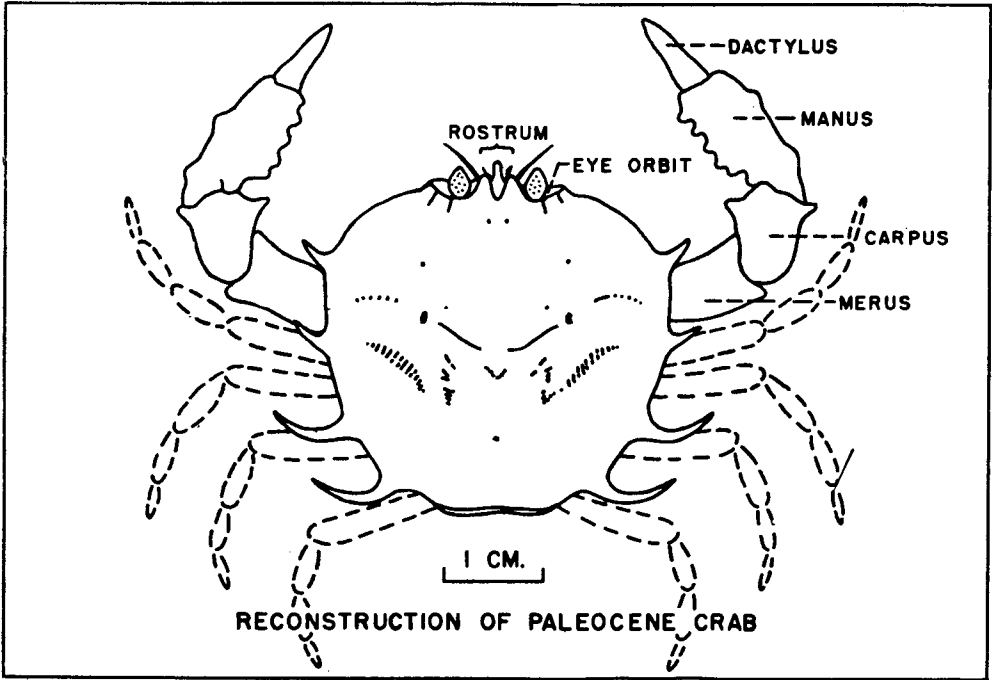
Etymology.—*καμάρα* (camara) f., vault; plus *καρκίνος* (carcinus) m., crab.

Description.—The generic characters are inextricably bound up with the specific characters until other species are discovered and described. Likely to be distinctive of the genus, however, are such characters as the broadly obovate, strongly arched carapace; the narrow trifold rostrum between deep-set lateroventrally slanted orbits; the four strong postero-lateral spines; and the laterally flattened spinose propodus.

CAMAROCARCINUS ARNEOSONI n. sp.

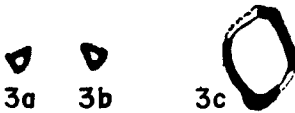
Pl. 74, figs. 1-14; text-figs. 2,3a,3b.

Description.—Carapace broadly obovate, only slightly longer than wide; strongly arched both transversely and longitudinally; greatest width well anterior to midlength; fronto-orbital width about 2/5 that of the carapace; four prominent spines on postero-lateral margin. Longitudinal curvature of carapace at midline gradual from rostrum to a position posterior to midlength and then dropping sharply to truncated posterior margin; transverse curvature more even throughout, slightly less towards lateral margins and greatest near midline. Antero-lateral margins evenly but strongly rounded from lateral edges of orbit to first lateral spine; postero-lateral margin gently curving to truncated posterior; postero-lateral margin about twice the length of antero-lateral margin. Rostrum trifold with lower upwardly curved medial point (rostrum proper) extending forward beyond



TEXT-FIG. 2—Diagrammatic scale reconstruction of *Camarocarcinus arnesoni* Holland & Cvanara, n. gen., n. sp. Dashed lines hypothetical and the eyes, antennae, and antennules are completely hypothetical. The merus (?) of one ambulatory leg is known, but it is more slender than any shown here. The carpi of the chelipeds are shown rotated rather too far inward and the meri are a bit heavy. The chelipeds were likely carried folded closely in against the front of the body. The round axial posterior dot indicates the position of the cardiac node; the other marks indicate indentations of the exoskeleton.

orbits; paired lateral points or supra-orbital spines prominent and extending forward horizontally, not curved. Orbits deep-set, oval, about 1.5 times as wide as high, long dimension slanted downward and outward at about 45° angle; lateral margins of orbits



TEXT-FIG. 3—Transverse section (×1) through dactyli of Cannonball crabs as viewed from anterior. 3a, 3b, *Camarocarcinus arnesoni* Holland & Cvanara, n. gen., n. sp., section about 2 mm. anterior to junction of dactylus and manus; 3a, right dactylus UND 693; 3b, left dactylus UND 573; 3c, *Ranina* (?) *burleighensis* Holland, n. sp., left dactylus (holotype, USNM 562094) section through first prehensile tooth; dotted lines indicate where exoskeletal material is missing.

marked by heavy, pronounced, lateral spines; upper orbital margin flaring slightly upward and outward and bearing two distinct fisure. Antero-lateral margin set with low irregular granules; postero-lateral margins each set with four discrete, sharp-pointed spines. The anterior spine is nearly triangular with the apex directed anteriorly and upward, the second spine is slightly longer, more slender, very sharp and curved upward and anteriorly; the third, removed approximately the same distance from the second as the second is from the first, is longer, more curved, and shaped like the posterior spine; the latter is set near the posterior margin at a lesser distance from the third spine than separates the others, and is long, horn-like, and strongly curved upward and anteriorly.

Surface of carapace completely and regularly marked with circular (presumably

setiferous) various-sized pits which bear either elevated or depressed rims of darker exoskeletal material. Bodily regions, in general, poorly defined. A broad poorly defined axial ridge is discernible; this ridge commonly bears a marked cardiac aerolation, and the branchial regions are usually swollen. The cervical groove consists medially of a pair of short posteriorly arcuate grooves ending toward the center in a pair of deeper indentations on either side of the midline; these grooves make an obtuse angle of about 120° . Antero-laterally beyond this inner part is a deep, large, subcircular pit; still beyond is an outer curved part of the cervical groove, consisting of a row of faint coalescing pits, which terminates near the lateral margin between the first and second spine. Cardiac grooves indefinite, merely a series of pits; from the posterior end of these a semi-lunar line of muscle imprints curves forward toward the second spine; from the anterior end an indistinct V-shaped series of muscle imprints crosses the axial ridge. Within the anterior half of the carapace on each side of the axial ridge are several pits: one about 3 mm. inward and forward of the large pit which interrupts the cervical groove, another larger pit about 5 mm directly anterior of the large pit of the cervical groove, and a pair just posterior to the rostrum. A low but distinct rim is rolled up at the posterior margin of the carapace.

Chelipeds about equal in size or right slightly larger than left. Coxa unknown; basis fused to ischium although juncture is visible; basio-ischium short and smooth, slightly swollen distally; merus long, moderately heavy, essentially smooth but with fine spinules throughout length along outer lower edge. Carpus distinctive, short, inflated laterally, rounded proximally, triangular distally when viewed from the side. The rounded proximal portion overlaps the merus in a depressed articulation furrow while the distal triangular part greatly overlaps the manus on its upper surface; a short heavy spine is borne at each angle of the triangle of the carpus. Manus elongated, laterally compressed, inner surface smooth and nearly flat, outer surface inflated and tuberculate, upper surface nearly flat or slightly rounded, inferior surface rounded

or slightly keeled distally; thus in cross-section the manus is subtriangular. The upper surface of the manus bears a row of tubercles and spinules on its inner margin; there is also a posteriorly directed tubercle on the upper surface where the apex of the distal triangular end of the carpus articulates with the manus; outer surface marked by two spinules, the distal one conical, the proximal one double, with a low ridge between them; lower margin of manus bearing eight to twelve irregularly spaced spine bases; all surfaces granular and pitted except inner surface which is commonly quite polished. Pollex deflected sharply downward, otherwise unknown. Dactylus apparently short, tapering rapidly (extremity unknown), subtriangular in transverse section; upper surface flat, keeled on inner and outer edges; granular and pitted on upper and outer surface; prehensile teeth lacking or unknown.

Ambulatory legs virtually unknown; first two apparently unequal in size; one dissociated leg is long, thin, laterally crushed, with merus (?) bearing spine bases on lower (?) margin.

Third maxillipeds relatively slender but inflated (at least posteriorly) bearing granules and smaller setiferous pits on outer surface; exognath nearly as heavy as endognath but more curved; exognath tapering anteriorly. Coxa of third maxillipeds inflated; basis of endognath fused to ischium but suture depressed and readily visible; ischium long, flattened or slightly inflated; merus long, thin, flat, and sharply deflected dorsally (usually fractured) at junction with ischium extending far forward to base of antennules just beneath rostrum; palp unknown. Anterior sternal segment apparently indented by a notch at posterior edge. Broken stubs of antennules located close together just below rostrum even with lower margin of orbits; antennule stubs oval and marked by pits which were apparently setiferous.

Pterygostomial region inflated especially anteriorly; densely covered with setiferous pits; interior edge of pterygostomium with reflexed rim.

Abdominal segments smooth, or minutely granulose, shiny, transversely arched, with a broad raised axial region, and on each side

of this a raised lateral region; each segment save the terminal segment bears a transversely elongate median spine or tubercle and two smaller lateral tubercles, one on each lateral region. Terminal segment broad, flat, ovate with median ridge set with two transverse nodes. Genital openings unknown.

Measurements.—All measurements were made in millimeters according to the prescription of Rathbun (1918, p. 9, or 1930, p. 4). Where two sets of numbers are given for segments of chelipeds, the upper set indicates the right cheliped.

lected by W. W. Arneson, F. D. Holland, Jr., A. M. Cavanaugh, and R. G. Monroe.

Horizon and type locality.—Cannonball formation, Paleocene; loose on surface approximately 6 feet below top of exposure; sand blow-out, ditch west side of road, N. E. Corner Sec. 28, T. 137 N., R. 77 W., 5 miles west and 1.1 miles south of Moffit, Burleigh Co., North Dakota (Locality No. 1).

Discussion.—Although many morphological features of this species are well-preserved and clear, certain of the critical major characters, such as the genital openings and thoracic sterna, are obscured; thus

No.	Carapace		Fronto-Orbital Width	Rostrum		Cheliped		
	Length	Width		L.	W.	Merus	Carpus	Manus
USNM 562093	37.4	35.4	13.2	4.1	6.1	— —	— —	11.4 7.4
						— —	10.2 8.4	12.0 7.5
UND 572	42+	42.8	—	—	—	—	— —	
UND 573	—	33.3	12.0	—	—	— 6.1	9.8 7.3	9.8 6.5
						— —	— —	— 6.3
UND 574	—	—	—	—	—	— —	— 8.0	13.1 7.4
						— —	— —	— —
UND 705	?34	?38+	?13.6	5.5	7+	— —	— —	— —
UND 575	35+	36.2	13.8	—	—	— —	— —	— —
UND 717	—	39.9	—	—	—	— 6.0	— —	— —

Types.—Holotype: U. S. National Museum No. 562093. All other types are in the University of North Dakota collections. Paratypes: UND 571 (partial dorsal carapace in matrix); UND 572 (large fractured carapace with abdomen also preserved); UND 573 (carapace with left propodus separate); UND 574 (right carpus and manus); UND 575 (carapace with abdomen; unfigured); UND 691 (badly broken carapace but with excellent left third maxilliped; unfigured). Figured hypotypes: UND 705 (badly crushed dorsal carapace); UND 693 (partial carapace with well preserved right carpus and propodus). Col-

its affinities are not clear. The genus has been tentatively placed in the Raninidae but this is open to serious question. Regarding the *Gymnopleura* Roger (1953, p. 350) says, "Ce sont les *Raninidae* de Dana et formes voisines, que l'ornementation chagrinée et la contour de la carapace caractérisent suffisamment." However, he makes no attempt to break down this superfamily. Rathbun (1926, p. 89) characterizes the Raninidae as having the anterior thoracic sterna broad, the posterior thoracic sterna narrow and keel-like, female genital openings on the coxae, last pair of pereopods dorsal, thoracic nerve ganglion-chain elon-

gate, antennary sternum triangular, and eight branchiae on each side. None of Rathbun's criteria is discernible on *Camarocarcinus*. The shagreen ornamentation mentioned by Roger is present, but the shape is not raninoid since *Camarocarcinus* lacks the wide toothed front and carapace which tapers posteriorly.

Markings of the dorsal surface are strikingly reminiscent of *Notopocorystes dichrous* Stenzel (Stenzel, 1945, p. 439; compare Text-fig. 2 with Stenzel's Fig. 13). The cervical grooves have approximately the same weight, the two close-set indentations posterior to the rostrum (tip of mesogastric region) are similar; and while the cardiac grooves of *Notopocorystes* are much deeper, the whole pattern of branchiocardiac grooves are not dissimilar.

The strongly convex carapace, the poorly defined body regions, and the spines situated so far posterior call to mind the Leucosiidae (cf. *Persephona*). Yet here again, one is frustrated by preservation, for this family is characterized by the hard hemispherical carapace and by having the branchial openings situated on either side of the mouth at the bases of the third maxillipeds. However in the Oxystomata (the superfamily here concerned), the buccal framework is triangular, but it is not in *Camarocarcinus*.⁴

Although the systematic position is thus left in doubt, several morphological details admit discussion. Apparently the outer mouth parts, or third maxillipeds, were particularly robust, for the preservation of these structures is truly amazing. Although not all of the features herein described were preserved on any one specimen, the various segments were in general well preserved whenever the ventral surface could be seen, and the sutures and articulations were clearly visible. Usually both the endognath and exognath appear somewhat flattened rather than inflated. How much of this is natural and how much is due to compression is not known; the merus at least seems to be naturally flat; the in-

flated, rounded character becomes more apparent posteriorly on the other segments.

One of the most immediately striking features is the surface ornamentation. Of the observable portions none seems to be entirely free of the crateriform pits. The pterygostomium is less densely covered than is the dorsal surface, and on the anterior of the pterygostomium anteriorly directed granules partially replace the pits; the pits, however, are present between these granules although they become finer posteriorly. The outer and under surface of the pereopods, although not generally as well preserved as other parts of the organism, seem to be nearly free of the pits. The upper surface of the manus and dactyli of the chelipeds are densely covered, however. The abdomen is virtually free of minute ornamentation although tiny crateriform pits appear near the lateral boundaries of the abdominal segments. On the third maxillipeds the pits are very tiny and lack the rim so that the maxillipeds appear much smoother than most of the surface.

Withers (1927, p. 178-179) described and illustrated the surface of *Ranina trechmanni* and Stenzel (1945) has compared this with *Notopocorystes dichrous* Stenzel. The surface of both of these is marked by pits and flattened granules "which are so closely set that the interspaces are mere chinks" (Stenzel, p. 440). This is not true in *Camarocarcinus*; nor are the pits arranged in circlets, and they never intersect as in *Ranina trechmanni* (Withers, p. 129, Fig. 1). Each pit is a discrete entity, with a raised rim, the center filled with a white calcareous (?) clay-sized matrix, and with a pore piercing the exact center. On broken edges and in thin sections these pores are seen to penetrate the several exoskeletal layers. The crateriform pits are of two or three orders of size, but the smaller pits are irregularly placed throughout and not grouped around the primary pits; some minute granules of a fourth order in size are present. Over the whole dorsal surface, in the interspaces between the pits, runs an irregular anastomosing set of faint, tiny grooves. The major indentations that form the muscle imprints are devoid of pits. Since these pits appear to bear pores, and since many (at least the larger pores) are seen to penetrate to the

⁴ The suggestion of Dr. Chace that, based on shape of the carapace, *Camarocarcinus* be placed "near the atelecyclids such as *Pliosoma*, *Corys-toides*, and *Bellia*" (letter to senior author dated April 26, 1957) merits serious consideration; yet there are objections to this systematic placement.

inner surface these are interpreted by the writers as having been setiferous. If that be true, *Camarocarcinus* was hirsute indeed! The hairs were undoubtedly of survival value in filtering the sand as described by Bourne (1922) and Borradaile (1922); the clogging of the hairs of the ventral surface by a too rapid influx of sand likely caused the demise of the creatures.

As preserved, the holotype is dusky brown (5 YR 2/2) to brownish black (5 YR 2/1), but other specimens range from these colors to grayish brown (5 YR 3/2) or brownish gray (5 YR 4/1). Most of the specimens are of the darker values with the pereopods still darker; however the white filling in the pits tends to make the exoskeletal material appear deceptively light in value when viewed casually.

The species is named in honor of the finder and donor of the original specimens, Mr. William W. Arneson.

Genus RANINA Lamarck, 1801

RANINA (?) BURLEIGHENSIS Holland, n. sp.
Pl. 74, fig. 15; text-fig. 3c.

While making the final study of crab fragments from Locality No. 1, the senior author discovered a single fragmental left propodus of a seemingly raninoid crab. Since this specimen appears to be entirely different from *Camarocarcinus*, and since the junior author has not had an opportunity to study the specimen, the senior author accepts full responsibility for the new species here proposed.

Description.—The holotype (only known specimen) is black and consists of the broken distal portion (two-thirds?) of the left manus, the stub of the pollex or immovable finger, and the proximal part of the dactylus of a rather large propodus. The manus, though laterally crushed, appears to have been oblong in cross-section with the width about three-fourths the height. The outer surface of the manus is covered with irregularly spaced, asymmetrical tubercles which are inclined forward. Between the tubercles are smaller, more symmetrical, rounded granules. Inner surface similar but with the tubercles less pronounced. The tubercles apparently disappear toward the upper surface and on the pollex. On upper distal corners of the manus near the articulation

of the dactylus is situated a pair of spine bases. The base of a single, small, forward-directed spine can still be seen on the outer surface near the junction with the pollex.

The dactylus is so broken that it is impossible to determine its length. On the inferior surface a rounded projection appears near the break, 6.5 mm. anterior to the junction with the manus; this projection is presumed to be the first prehensile tooth. The section shown as Text-fig. 3c is drawn through this tooth, and the measurements of the dactylus given below were made at this position. At this place the dactylus is subovate but it expands rapidly in a proximal direction and becomes flatter on the superior surface.

Posteriorly directed projections occur on the upper proximal corners of the dactylus; the projections apparently articulated with poorly preserved sockets in the upper distal corners of the manus. A spine base of an anteriorly directed spine is borne on the distal edge of each projection (the inner spine was observed by the writer but broke during preparation). The dactylus is covered with irregularly spaced shallow pits.

Although little remains of the pollex, it appears almost rectangular in cross-section, pitted like the dactylus, and inclined downward from the manus.

Measurements.—All measurements were made in millimeters according to the prescription of Rathbun (1918, p. 8); see also Menzies (1951, p. 169).

	Measured	Estimated
Manus		
length	16.8	29.0
height	22.4	24.0
width	18.0	18.5
Dactylus		
length	13.2	?
height	13.3	13.3
width	9.2	9.2
Pollex		
length	4.5	?
height	?	6.3
width	15.0	15.0

Type.—Holotype (only specimen): U. S. National Museum No. 562094.

Horizon and type locality.—Cannonball formation, Paleocene; loose on surface approximately 6 feet below top of exposure; sand blow-out, ditch west side of road, NE corner Sec. 28, T. 137 N., R. 77 W., 5 miles

west and 1.1 miles south of Moffit, Burleigh County, North Dakota (Locality No. 1).

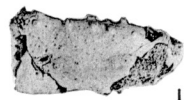
Discussion.—The generic assignment is made with considerable misgivings, yet the downward deflection of the pollex, the flattened upper surface of the dactylus (and presumably the manus), and the granulose ornamentation is reminiscent of raninids. However, the large size militates against this assignment; but no other generic assignment is apparent to the writer.

The specific name is derived from Burleigh County, North Dakota.

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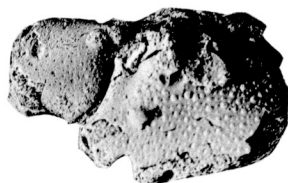
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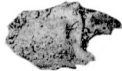
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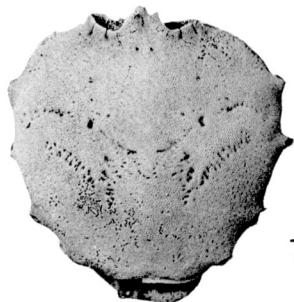
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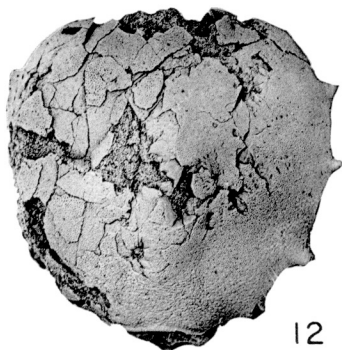
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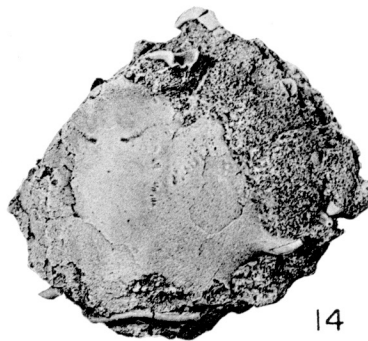
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