

**A new burrowing crayfish of the genus *Cambarus* Erichson, 1846
(Decapoda: Cambaridae) from the lower Flint River basin in the
Dougherty Plain of Georgia, with notes on *C. (D.) harti* Hobbs, 1981**

John E. Cooper and Christopher E. Skelton

(JEC) North Carolina State Museum of Natural Sciences, Research Lab, 4301 Reedy Creek Road,
Raleigh, North Carolina 27607, U.S.A., e-mail: john.cooper@ncmail.net;

(CES) Georgia Department of Natural Resources, Wildlife Resources Division, Nongame Wildlife
& Natural Heritage Section, Georgia Natural Heritage Program, 2117 U.S. Highway 278 S.E.,
Social Circle, Georgia 30025-4714, U.S.A.;

(Present address for CES) Department of Biological and Environmental Sciences,
Georgia College & State University, CBX 081, Milledgeville, Georgia, 31061, U.S.A.,
e-mail: cskelton@gcsu.edu

Abstract.—*Cambarus (Depressicambarus) doughertyensis* is a new species of obligate burrowing crayfish known from a single locality in the lower Flint River basin in the Dougherty Plain of the East Gulf Coastal Plain, Dougherty County, Georgia. It appears to be most closely related to *Cambarus (D.) harti* Hobbs, which is known from two localities in the western Piedmont Plateau, Meriwether County. Although the two species are morphologically similar in many respects, *C. (D.) doughertyensis* differs from *C. (D.) harti* in having a longer areola; a plethora of tubercles on the carpus and ventral surface of the palm; more tubercles on the opposable surfaces of both fingers of the chela, and differences in the morphology of those surfaces; a lack of spines or tubercles on the proximal podomere of the uropod; a radically different color pattern; and in a number of other characters. Spines on the ventral keel of the rostrum of crayfishes other than certain Mexican crayfishes of the genus *Procambarus* Ortmann are reported for the first time. Inadvertent errors in the description of *C. (D.) harti* are corrected.

Five similar species of highly specialized, obligate burrowing crayfishes of the genus *Cambarus* Erichson, 1846, subgenus *Depressicambarus* Hobbs, 1981, *latimanus* Group Bouchard 1978, are known to occupy limited, widely separated ranges in Georgia (Hobbs 1981). *Cambarus (D.) cymatilis* Hobbs, 1970, occurs in the Conasauga-Coosa River basin in the Ridge and Valley physiographic province; *Cambarus (D.) harti* Hobbs, 1981, is known from the Flint-Chattahoochee River basin in the western Piedmont Plateau; *Cambarus (D.) reflexus* Hobbs, 1981, occupies parts of the Savannah and Ogeechee River basins in the Atlantic Coastal Plain and eastern Fall Line

Hills District; *Cambarus (D.) strigosus* Hobbs, 1981, is limited to the Savannah River basin in the eastern Piedmont Plateau; and *Cambarus (D.) truncatus* Hobbs, 1981, is known only from the Oconee River basin in the Fall Line Hills District. Of these five crayfishes, *C. (D.) harti*, which is cobalt blue, occupies the southwesternmost range, and is known only from wetlands at two localities in Meriwether County. Its type locality is within the Cold Spring Creek subdrainage of the upper Flint River, the other is within the Flat Shoal Creek subdrainage of the Chattahoochee River, about 18.4 air km northwest of the type locality.

On 20 May 1999, CES excavated a num-

ber of chimneyed burrows in a seasonally flooded swamp forest adjacent to the floodplain of Kiokee Creek, a tributary of the lower Flint River in the Dougherty Plain of the East Gulf Coastal Plain in Dougherty County. This locality is about 147 air km south-southeast of the type locality of *C. (D.) harti*. The initial digging efforts produced four specimens of a relatively drab, brownish crayfish that superficially resembled *C. (D.) harti* except in color pattern. Additional specimens have since been collected, and it is apparent that this animal is an undescribed species related to *C. (D.) harti* and the four other previously mentioned species. Examination of these specimens also revealed the presence of spines on the ventral keel of the rostrum, a character that has been reported only in some Mexican crayfishes of the genus *Procambarus*, subgenera *Paracambarus* Ortmann, 1906, and *Villalobosus* Hobbs, 1972 (Villalobos 1955, 1983). Confusing statements in the original description of *C. (D.) harti* are clarified, based on a recent examination of the primary types.

Measurements of crayfish structures were made to the nearest 0.1 mm with a Fowler precision dial caliper, following the methods of Hobbs (1981:9–10) except where noted. Abbreviations used in the paper are: GMNH, University of Georgia Museum of Natural History, Athens; j, juvenile; NCSM, North Carolina State Museum of Natural Sciences, Raleigh; PCL, postorbital carapace length; TCL, total carapace length; USGS, United States Geological Survey; USNM, National Museum of Natural History, Smithsonian Institution, Washington, D.C.; UTM, Universal Transverse Mercator.

Cambarus (Depressicambarus)
doughertyensis, new species

Fig. 1, Table 1

Diagnosis.—Body and eyes pigmented, eye small (\bar{x} adult diam. 1.2 mm, $n = 15$). Rostrum with slightly thickened, elevated margins, subparallel or moderately con-

verging to base of short acumen, which not delimited by tubercles or spines; margins constricted at base of acumen, strongly converging and concave from there to small, dorsally directed apical tubercle; acumen comprising 28.6–42.9% ($\bar{x} = 34.6\%$) of rostrum length, latter constituting 11.7–13.3% ($\bar{x} = 12.5\%$) of TCL; floor (dorsal surface) of rostrum broadly concave, cephalic half cuplike; ventral keel of rostrum bearing 1–4 corneous spines. Areola obliterated or nearly so, length constituting 40.9–45.6% ($\bar{x} = 43.7\%$) of TCL and 46.2–51.2% ($\bar{x} = 48.9\%$) of PCL. Thoracic section of carapace dorsally crowded with punctations, dorsolaterally and laterally granulate or with small tubercles; cephalic section laterally with many, usually small, tubercles. Cervical spines reduced to tubercles, one to several each side of carapace. Postorbital ridge moderate, cephalic margin rounded and without spine or tubercle. Suborbital angle obsolete to broadly obtuse, without tubercle or spine; branchiostegal spine vestigial or a small tubercle. Antennal scale 2.5–3.1 ($\bar{x} = 2.8$) times as long as wide, greatest width at midlength; lateral margin thickened and terminating distally in long spine, lamella narrow, cephalic margin moderately or strongly declivous, mesial margin subparallel to lateral margin; antennal peduncle without tubercles or spines.

Palm of chela inflated, 1.7–1.9 ($\bar{x} = 1.8$) times wider than deep, depth 89.5–98.6% ($\bar{x} = 95.2\%$) of length of mesial margin, width 1.6–1.9 ($\bar{x} = 1.7$) times length of mesial margin; latter constituting 26.3–31.3% ($\bar{x} = 28.9\%$) of total chela (propodus) length, bearing subserrate mesial row of 6 (rarely 5 or 7) large, semierect tubercles, row subtended dorsally by second row of 5 or 6 (rarely 3 or 4) smaller ones, and other smaller but produced tubercles dorsolateral to this row; 1 or 2 small, produced tubercles ventral to mesial row. Fixed finger of chela costate laterally, with strong median ridge dorsally and weak submedian ridge ventrally; opposable surface of finger with row

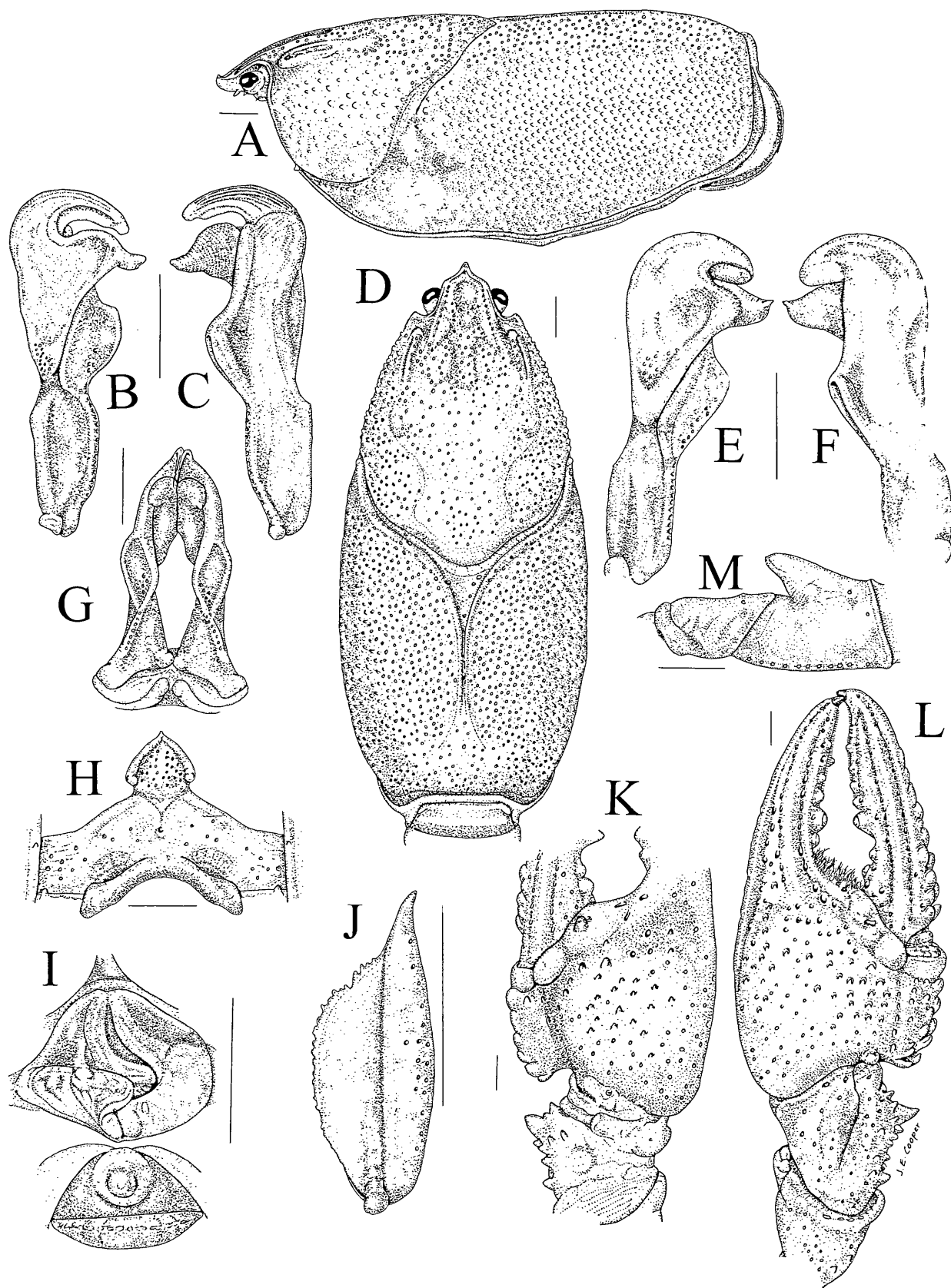


Fig. 1. *Cambarus (Depressicambarus) doughertyensis*, new species; all from holotypic male, form I (NCSM 7997), except E, F from morphotypic male, form II (NCSM 7999), and I from allotypic female (NCSM 7998): A, lateral aspect of carapace; B, E, mesial aspect of gonopod (first pleopod); C, F, lateral aspect of gonopod; D, dorsal aspect of carapace; G, caudal aspect of in situ gonopods; H, epistome; I, annulus ventralis and postannular sclerite; J, antennal scale; K, ventral aspect of left palm; L, dorsal aspect of distal podomeres of left cheliped; M, basis and ischium of third pereiopod. Scale line = 2 mm.

Table 1.—Measurements (mm) of types of *Cambarus (Depressicambarus) doughertyensis*, new species.

	Holotypic male, form I	Allotypic female	Morphotypic male, form II
Carapace			
Total length	28.5	29.0	29.4
Postorbital length	25.7	25.8	26.2
Width	14.5	14.5	14.7
Depth	11.0	11.4	11.2
Length rostrum	3.4	3.7	3.8
Length acumen	1.2	1.4	1.3
Length areola	12.7	12.7	13.0
Width areola	0.2	oblit	oblit
Antennal scale			
Length	3.2	3.2	3.4
Width	1.1	1.3	1.1
Abdomen			
Length	25.5	26.4	26.0
Width	10.1	10.7	10.3
Cheliped			
Length propodus	22.1	21.5	24.4
Length mesial margin palm	6.5	6.4	7.0
Width palm	11.5	11.1	12.6
Depth palm	6.0	6.3	6.9
Length dactyl	14.6	14.0	15.8
Gonopod length	6.8	N/A	7.1

of 5–7 (rarely 8) tubercles, in addition to subconical tubercle ventral to denticles, third tubercle from base usually very large; dactyl length 2.2–2.6 ($\bar{x} = 2.3$) times length of mesial margin of palm, with very strong median dorsal ridge and weak submedian ventral ridge; mesial surface of dactyl with strong, broad tubercles on proximal two-thirds or more; opposable surface with row of 9–12 (usually 9 or 10) tubercles, fourth from base usually very large. Carpus with weak dorsomesial tubercles; large, stout, conical spine at distal margin of mesial surface; 2 low, subconical distal mounds at distal margin of ventral surface; and multiple strong tubercles on mesial and ventral surfaces; merus with 2–4 small subdistal dorsal tubercles, 4–6 (usually 5) tubercles on ventrolateral ridge, and 7–11 (usually 9 or 10) tubercles on ventromesial ridge.

Abdomen shorter and considerably narrower than carapace; proximal podomere of uropod without tubercles or spines; mesial

ramus with small caudolateral and caudo-median spines, latter submarginal.

Hook on ischium of third pereopod of males, that of holotypic male, form I (Fig. 1M) uniramous, tapered, oblique, overreaching basioischial articulation by most of length, opposed by very weak tubercle on basis; coxa of fourth pereopod of males with vertically disposed, caudomesial boss.

In situ gonopods (first pleopods) of form I male (based on holotypic male; Fig. 1G) symmetrical; proximomesial apophyses moderate, partly rounded; pair of bulbosities on base below apophyses; central projection directed caudally; mesial process inflated at base, tip extruded, directed caudally and inclined slightly proximally; in lateral aspect (Fig. 1C), central projection curved over 90° to plane of shaft, slightly tapered, not recurved, with moderate, proximally directed subapical notch; tip extending proximally nearly to distal margin of mesial process but not as far caudally as tip

of latter; mesial process subglobose, distal margin arched; tip of process extruded, subacute, caudally directed; caudal process represented by small, rounded protuberance; in mesial aspect (Fig. 1B), setae at midlength of shaft and some near proximocaudal margin of caudal curvature.

Annulus ventralis (based on allotypic female; Fig. 1I) about 1.5 times wider than long, subovate in ventral outline; cephalic half moderately depressed, with broad, uneven median trough flanked each side by strong ridge; cephalomedian margin domed, with median concavity; sinistral ridge of cephalic half descending obliquely to join upper arm of reverse C-shaped caudosinistral wall, dextral ridge slightly curved, descending to cephalic margin of caudodextral wall; caudosinistral wall inflated, rounded caudally and laterally, caudodextral wall long, nearly horizontal, less inflated but broad; transverse tongue originating at broad median end of caudodextral wall, proceeding horizontally to plunge into deep fossa beneath sinistral wall; sinus not dissecting caudal margin. Mirror image of this configuration observed in 7 of 10 females.

Measurements of type specimens provided in Table 1.

Description of holotypic male, form I.—Body and eyes pigmented, eye 1.4 mm diameter. Cephalothorax (Fig. 1A, D) subcylindrical, thoracic section 1.3 times wider than deep. Areola nearly obliterated, 1 punctation in narrowest part, length constituting 44.6% of TCL (49.4% of PCL). Rostrum with relatively thick, strongly elevated margins slightly converging to base of short acumen, where sharply constricted, more convergent and concave to small, dorsally directed apical tubercle; latter reaching midlength of penultimate podomere of antennular peduncle; acumen comprising 35.3% of rostrum length, latter constituting 11.9% of TCL; floor of rostrum excavate, cephalically cuplike, sparsely punctate, with usual row of deep punctations along inner surface of dorsal ridge; subrostral ridge strong, visible to base of acumen in

dorsal aspect; ventral keel of rostrum with 2 corneous spines.

Postorbital ridge fairly strong, poorly defined ventrally, inflated caudally; groove shallow, lateral; cephalic margin rounded. Suborbital angle obsolete, margin without tubercle or spine; branchiostegal spine reduced to small tubercle. Thoracic section of carapace dorsally crowded with deep punctations, dorsolaterally and laterally granulate; row of small tubercles along ventral margin of anterior section of cervical groove; cephalic section of carapace 1.2 times longer than areola, constituting 55.5% of TCL; laterally with many scattered, small to moderate, tubercles, gastric region with scattered punctations. Cervical spine region with 1 tubercle and several granules.

Antennal peduncle devoid of spines or tubercles; tip of adpressed antennal flagellum reaching caudal margin of third tergite; antennular peduncle with very small, subdistal median spine on ventral surface of basal podomere. Antennal scale (Fig. 1J) 2.9 times as long as wide, broadest near midlength; lateral margin slightly convex, thickened, terminating in long spine, tip of which reaching distal margin of penultimate podomere of antennular peduncle; lamella 1.2 times width of thickened lateral portion, distal margin strongly declivous from base of spine, mesial margin subparallel to lateral.

Abdomen narrow, greatest width 69.7% of greatest carapace width; length 89.5% of TCL; abdominal pleura fairly short, rounded ventrally and caudally; terga with many large punctations, except articular surfaces glabrous. Proximal podomere of uropod without spines or tubercles; mesial ramus of uropod with weak median ridge bearing very small, submarginal caudomedian spine; caudolateral spine of ramus very small; cephalic section of right lateral ramus of uropod with weak ridge, caudal margin of transverse flexure bearing total of 19 fixed spines and 1 long, articulated sublateral spine (15 fixed and 1 sublateral on left). Telson with 2 spines in right caudo-

lateral corner of cephalic section, innermost articulated, left corner with single fixed and 2 articulated spines; transverse flexure strong, caudal margin broadly rounded.

Epistome (Fig. 1H) with subcordiform to subtriangular cephalic lobe bearing short cephalomedian projection; margins of lobe relatively narrow, moderately elevated, lateral corners produced as tuberclelike protuberances; floor (ventral surface) broadly convex, very punctate; central depression shallow, with deep median fovea; lamellae very broad, moderately punctate, laterally truncate, with 1 small tubercle and 1 strong caudal tubercle each side; zygoma well arched, cephalolateral margins flanked by deep pit.

Third maxilliped with tip reaching mid-length of penultimate podomere of antennal peduncle; exopodite very hirsute, tip reaching nearly to midlength of merus of endopodite; distolateral corner of ischium subacute, lateral half apunctate, glabrous; mesial section very broad, with clumps of long bristles, mesial margin of right ischium with 21 denticles, 20 on left; incisor ridge of right mandible with 8 denticles, 7 on left.

Right cheliped regenerated; left chela (Fig. 1L) 1.9 times longer than wide, palm 1.9 times as wide as deep, width 1.8 times length of mesial margin; latter 29.4% of total chela (propodus) length, 44.5% of dactyl length. Dorsal surface of palm covered with mostly deep punctations, those on mesial half and some on lateral half with small basal tubercles; longitudinal dorsomesial sulcus weak, with row of small, produced tubercles; dorsolateral margin of palm costate for much of length (continuous onto fixed finger), with slight impression and large punctations, some with tubercles at proximal bases; articular ridge strong, lateral eminence with dense, short setae on distolateral margin, continuing onto base of opposable surface of fixed finger; lateral margin of palm with row of large punctations. Ventral surface of palm (Fig. 1K) very punctate, mesial portion sharply set off from greatly inflated portion; distolaterally

with weak depression (continuous onto fixed finger); lateral eminence of strong articular ridge with large, depressed, subconical subdistal tubercle; 3 strong and 3 weaker tubercles proximal to ridge (total of 13 obvious, produced tubercles on ventral surface). Mesial margin of palm with subseriate mesial row of 6 strong tubercles, row subtended dorsolaterally by row of 6 generally smaller tubercles, and 4 others dorsal to this row; 1 strong distal tubercle ventral to mesial row.

Fingers gaping except at tips, greatest width of gape slightly more than width of dactyl base, largest tubercles on opposable surfaces of fingers separated when fingers closed. Fixed finger costate laterally, inner margin of proximal fourth scalloped; dorsal surface with very strong, glabrous median ridge, flanked each side by deep punctate groove; lateral surface with row of large punctations; ventral surface with fairly strong ridge, closer to opposable margin than median in position, flanked mesially by row of coalescing punctations, laterally by slanted surface crowded with large punctations; opposable surface with relatively small subconical tubercle ventral to denticles at base of distal third or so of finger, and row of 5 other tubercles dorsal to or interrupting denticles, second from base largest; denticles in 1 or 2 rows. Dorsal surface of dactyl with very strong, glabrous median ridge, flanked each side by deep, punctate groove; mesial surface with very strong, broad tubercles on proximal three-fourths, basal tubercles in 3 rows, strongly encroaching dorsally, weakly encroaching ventrally; ventral surface with moderate, glabrous ridge, flanked each side by row of punctations; opposable surface with 9 tubercles, third from base largest, and excision in surface proximal to this tubercle; denticles in 1 row.

Carpus (Fig. 1L) 1.4 times as long as wide, 1.4 times as long as mesial margin of palm; dorsal surface of carpus with narrow, deep sulcus, lateral to which surface punctate, mesial to which surface with 3 dor-

somesial tubercles; mesial margin with short, stout distal spine, 1 moderate tubercle close to its proximal margin, and 9 other strong, often subacute, tubercles; ventral surface with 2 subconical distal mounds, and 1 strong and 1 smaller proximomesial tubercle. Merus 1.7 times longer than deep, distodorsal surface with 1 large, broad adpressed tubercle and 1 smaller tubercle; ventrolateral ridge with 6 small, rounded tubercles, none on articular condyl, which rounded, glabrous; ventromesial ridge with 8 subacute tubercles and short, stout distal spine; ischium with 4 small, subacute tubercles on ventral ridge.

See "Diagnosis" for description of gonopods.

Description of allotypic female.—Except for secondary sexual characters, differing from holotypic male in following respects: Areola obliterated, constituting 43.8% of TCL (49.2% of PCL). Acumen comprising 37.8% of rostrum length, latter constituting 12.8% of TCL. Postorbital ridge fairly weak, nowhere sharply defined. Cephalic section of carapace 1.3 times longer than areola, constituting 56.2% of TCL. Cervical spine region with 5 small tubercles and several granules. Greatest width of abdomen 73.8% of greatest carapace width, length 91.0% of TCL. Telson with single fixed spine in each caudolateral corner of cephalic section, transverse flexure weak, caudal margin domed.

Palm of chela 1.8 times broader than deep, width 45.7% of length of mesial margin, latter 29.8% of total chela length, 45.7% of dactyl length; dorsomesial sulcus of palm obliterated; ventral surface with total of 10 obvious, produced tubercles. Opposable surface of right fixed finger with broken subconical tubercle ventral to denticles at base of distal fourth of finger, row of 8 other tubercles (6 on left finger), third from base massive. Opposable surface of right dactyl with 10 tubercles, fourth from base massive. Carpus 1.3 times as long as wide, mesial surface with 10 tubercles of varying sizes and shapes in addition to

short, stout distal spine. Right merus with 1 moderate and 4 weak, rounded distodorsal tubercles (3 moderate tubercles on left); ventromesial ridge with 10 tubercles (9 on left), in addition to distal spine; ischium with 2 small ventral tubercles each limb.

First pleopods strong, distally hirsute; preannular sternite relatively narrow, walls steep (see "Affinities"); ventral surface of postannular sclerite (Fig. 11) with large, subconical papilla.

See "Diagnosis" for description of annulus ventralis.

Description of morphotypic male, form II.—Differing from holotype in following respects: Areola obliterated, constituting 44.2% of TCL (49.6% of PCL). Ventral keel of rostrum with single spine near base. Branchiostegal spine obsolete. Cephalic section of carapace 1.3 times longer than areola, constituting 55.8% of TCL. Greatest width of abdomen 69.7% of greatest width of carapace, abdomen length 88.4% of TCL. Telson with 1 very small fixed spine and 1 minuscule articulated spine in right caudolateral corner of cephalic section, all spines congenitally absent from left. Lateral corner of lamella of epistome devoid of tubercles; zygoma moderately arched.

Right cheliped regenerated; palm of left chela 1.8 times broader than deep; length of mesial margin 28.7% of total chela length, 44.3% of dactyl length; ventral surface of palm covered with tubercles of various sizes; subconical tubercle on lateral eminence of articular ridge originating at proximal margin of ridge, not adpressed; 3 large tubercles proximal to ridge. Largest tubercle on opposable surface of fixed finger second from base, largest on opposable surface of dactyl fourth from base. Carpus length 1.5 times length of mesial margin of palm; dorsal sulcus short, flanked mesially by row of 3 tubercles; mesial surface with total of 11 tubercles in addition to usual stout subdistal spine; ventral surface with single proximomesial tubercle. Distodorsal surface of left merus with 1 moderate, subconical and 2 smaller, rounded tubercles; ventrolateral

ridge with 5 very small tubercles, none on distal condyl; ventromesial ridge with 11 small, conical tubercles.

Hook on ischium of third pereopod moderate, not overreaching articulation, opposed by extremely weak tubercle on ventral surface of basis. In situ gonopods with moderate, nearly abutted proximomesial apophyses; in lateral aspect (Fig. 1F), central projection broad, slightly tapered, not reaching as far caudally as tip of mesial process; latter inflated nearly entire length, directed caudally, tip subtruncate and with small, spiniform protuberance directed caudomesially; juvenile suture absent; in mesial aspect (Fig. 1E), short setae at mid-length of shaft.

Color notes.—Most specimens discolored by ferrous deposits; the following based on a live adult female.

Ground color of carapace brown, fading ventrally to pale greenish-brown, ventral margin orangish; cephaloventral area of lateral surface of cephalic section of carapace creamy orange. Coxa, basis, and ischium of cheliped orangish; merus brownish, fading to orangish ventrally and proximally; carpus brown dorsally, orangish ventrally, with orangish dorsomedian furrow. Large distal tubercle on mesial surface of carpus orange, all others orange-cream. Dorsal surface of chela greenish-brown, articular ridge orange; tips of both fingers orange, not subtended by black band; tubercles on mesial margin of palm and dactyl orangish; lateral surface of propodus orangish. Largest tubercle on opposable surface of dactyl and fixed finger cream; other tubercles on both fingers orange-cream. Proximodorsal part and merus of second through fifth pereopods orangish, fading to brownish on basis and ischium; ventral surfaces of these pereopods orangish. Dorsal surface of abdomen brown; cephalic part of all pleura pinkish-orange, color most obvious on cephalic two-thirds of second abdominal segment; uropods and telson light brown.

Type locality.—Georgia, Dougherty County, burrows in wetland just south of

access road near western boundary Albany Nursery Wildlife Management Area, ca. 12.8 km W of Albany (Pretoria 7.5" USGS quadrangle, UTM Zone 16, coord. 751779E, 3496706N). Locality within sub-drainage of Kiokee Creek, Flint River basin, Apalachicola River drainage.

Disposition of types.—The holotypic male, form I, allotypic female, and morphotypic male, form II, are in the NCSM crustacean collection (7997, 7998, and 7999, respectively). The following are designated paratopotypes: 1 j♂, 3 ♀ (5253), 22 Jul 1999, coll. CES, S. E. Cammack, E. E. Van De Genachte; 4 ♀, 2 j♀ (7987), 25 Feb 2001, coll. CES; 1 ♂ I (7988), 13 Aug 1999 (was ♂ II when collected), coll. CES, S. K. Berckman; 1 ♂ I, 1 ♀ (USNM 1004610), 2 Jun 1999, coll. CES, M. C. Freeman (MCF); 1 ♀ (GMNH 6239), 2 Jun 1999, coll. CES, MCF; 1 ♀ (23692); 14 May 2002, coll. CES.

Variations.—Some variations other than those previously addressed have been observed. In dorsal aspect, the margins of the rostrum are usually rather straight, and subparallel or only moderately convergent to the base of the acumen. In several specimens, though, the margins are slightly concave between the orbits, and in two very small females the rostrum is triangular. These juveniles also have marginal spines on the rostrum. In all specimens, the mesial (lamellar) portion of the antennal scale is only slightly wider than the thickened lateral portion, and the distomesial margin is moderately or strongly declivous from the base of the spine to the widest point. In some specimens the distomesial margin is deeply incised, bearing decidedly spinelike protuberances. In ventral outline, the cephalic lobe of the epistome varies in shape from subcordiform or subtriangular to subpentagonal, and in some specimens the margins are erose, with small angular protrusions. The central depression of the epistome is obsolete in 10 specimens, very shallow in the others, and always displays a deep fovea.

The greatest width of the abdomen varies from 69.1–74.8% (\bar{x} = 72.2%) of carapace width, and is only slightly wider in females than in males. The length of the abdomen varies from 86.5–95.2% (\bar{x} = 90.3%) of TCL. The number of spines in the caudo-lateral corner of the cephalic section of the telson is highly variable. Four specimens have a single fixed lateral spine and a single articulated inner spine in each corner. Four have two spines in one corner, and either a single fixed or articulated spine in the other. One specimen has no spines in one corner, two in the other; another has two spines in one corner, three in the other; and two specimens have a single fixed spine in each corner. In most specimens the articulated spines are very small.

In most specimens the punctations on at least the mesial half or third of the ventral surface of the palm have small basal tubercles, but the surface also bears from 6–13 prominent, produced tubercles, several of which may be very large. The largest tubercle on the opposable surface of the fixed finger is almost always the third (rarely the second or fourth) from the base; the largest tubercle on the corresponding surface of the dactyl is usually the fourth from the base, but often is the third, and occasionally the first and fourth tubercles are equally large. The total number of tubercles or spines on the carpus, excluding the stout distal spine of the mesial surface and the two stout distal tubercles or mounds of the ventral surface, ranges from 7–13 (usually 10–13). The ventral surface of the ischium of the cheliped bears from 2–4 (usually 3 or 4) small, subacute tubercles. The total length of the chela of adult males averages about 85% of TCL (94% of PCL), while the average for adult females is about 75% of TCL (84% of PCL).

Size.—The largest specimen is a female measuring 34.5 mm TCL (31.0 mm PCL). The largest form I male measures 31.0 mm TCL (27.5 mm PCL), the smallest 28.5 mm TCL (25.7 mm PCL). The smallest speci-

mens yet collected are two females with TCLs of 7.0 and 7.7 mm.

Life history notes.—Form I males were collected in May and July. A form II male, collected in August 1999, underwent two molts in the laboratory, became form I in January 2000. No ovigerous females or those with attached young have yet been found. The two very small females, possibly representative of recruitment size, were dug from the same burrow on 25 February 2001.

Ecological notes.—The type locality of *C. (D.) doughertyensis* is in a swamp forest dominated by an overstory of *Quercus* spp., *Nissa biflora*, and *Acer rubrum*, while the understory has abundant *Crataegus aestivalis*, *Sebastiania fruticosa*, *Rhus radicans*, and a variety of graminoids. The area is seasonally flooded, and in very wet periods produces a shallow outflow to Kiokee Creek. Burrows are typically found just above the standing water mark among roots of small trees and *Serenoa repens*. The soils in the area are Grady clay loams and provide easy digging for the first 25 cm. Below that, the soil becomes much more dense and is more difficult to excavate. When the water table is high, burrows are anastomosed and usually have four or five openings, often marked by well developed chimneys approximately 10 cm high and 15 cm across. In this situation, the animals are most often found in one of the horizontal passages about 30 cm below the surface. As the water table drops, burrows are marked by only two or three openings, with chimneys, that angle down to a single subvertical passage that penetrates the water table. The animals are then found in the vertical passage, 5 to 10 cm below the water level. When a burrow is excavated, the crayfish can rarely be induced to come to the air-water interface, and when encountered they are unmoving and rarely try to escape.

Crayfish associates.—*Faxonella clypeata* (Hay, 1899) was collected in open water in the swamp forest when flooded, and was dug from simple burrows when the water

table dropped. Two female *Cambarus* (*Depressicambarus*) cf. *C. (D.) striatus* Hay, 1902 (5157, 23691) and a female *Cambarus* (*Lacunicambarus*) *diogenes* Girard, 1852 (23690) were dug from separate burrows in the floodplain of Little Kiokee Creek, not far from the *C. (D.) doughertyensis* site.

Affinities.—*Cambarus (D.) doughertyensis* shares so many similarities with *C. (D.) harti* and several of the other small Georgia burrowers that, although some of them can undoubtedly be attributed to convergence and the channeling effect of adaptation to an obligate burrowing existence, it seems reasonable these species have descended from a common proximate ancestor. The annuli ventrales of some of the species are very similar, as are their narrow abdomens, many aspects of their chelipeds, rostra, antennal scales, suborbital angles, and branchiostegal spines, and other features. Some, including *C. (D.) harti*, also have spines on the ventral keel of the rostrum. They differ significantly, however, in many ways.

In *C. (D.) doughertyensis* the areola constitutes 40.9–45.6% (\bar{x} = 43.7%) of TCL and 46.2–51.2% (\bar{x} = 48.9%) of PCL, while in *C. (D.) harti* it constitutes 38.2–40.3% (\bar{x} = 39.4%) of TCL and 44.2–45.8% (\bar{x} = 44.8%) of PCL. Correspondingly, the cephalic section of the carapace in the former species is 1.2–1.4 times as long as the areola, while in the latter it is 1.5–1.6 times as long. The proximal podomere of the uropod in *C. (D.) harti* usually bears a small spine on both the lateral and mesial lobes, but such spines are lacking in *C. (D.) doughertyensis*. In *C. (D.) harti*, the preannular sternite of the female is broader and flatter than that of *C. (D.) doughertyensis*, which is narrow and steep. The width of this sternite, i.e., the distance between the ventral angles of the walls at their articulations with the mesial surfaces of the fourth coxae, is about 38% of carapace width in the former species, about 31% in the latter.

The ventral surface of the palm of the cheliped of *C. (D.) doughertyensis* (Fig.

1K), proximal to the articular ridge, bears many prominent, produced tubercles, whereas only a few such tubercles are present in *C. (D.) harti*. The opposable surface of the fixed finger of *C. (D.) doughertyensis* bears a row of from 5–8 tubercles in addition to the usual subconical tubercle ventral to the denticles, and there is a wide space between the base of the finger and the proximalmost tubercle. In *C. (D.) harti*, the number of tubercles that lie dorsal to the denticles is 4 or 5 (6 in one specimen). The opposable surface of the dactyl of *C. (D.) doughertyensis* bears 9–12 (usually 9 or 10) tubercles, whereas that of *C. (D.) harti* bears 5–7 tubercles. When the fingers of the chela are closed in *C. (D.) doughertyensis*, the largest tubercles on the opposable surfaces are separated from each other, but in *C. (D.) harti* the largest tubercles either abut or overlap. The carpus of *C. (D.) doughertyensis* usually bears from 7–13 spines or tubercles in addition to the large, stout distomesial spine and the two broad distoventral structures, whereas that of *C. (D.) harti* has 3 or 4 tubercles in addition to the usual. The former species has a shorter, deeper merus, in which the length averages 1.7 times the greatest depth, whereas in *C. (D.) harti* the merus averages twice as long as deep.

The following species differ from *C. (D.) doughertyensis* as indicated: *C. (D.) cymatilis* has a strong, usually subacute suborbital angle, the caudomedian spine on the mesial ramus of the uropod extends well beyond the caudal margin, and the color is blue; *C. (D.) reflexus* has a long, strongly recurved central projection and a well-defined caudal knob, both on the form I male gonopod, and the color is reddish or blue; *C. (D.) strigosus* has a row of plumose setae on the caudal border of the mesial process of the form I male gonopod, and a single spine in each cephalolateral corner of the telson; and *C. (D.) truncatus* usually lacks both caudomedian and caudolateral spines on the mesial ramus of the uropod and a transverse flexure in the telson, and

the form I male gonopod has a very short central projection.

The members of some Georgia populations of *C. (D.) striatus* and *Cambarus (Depressicambarus) latimanus* (LeConte, 1856) display multiple strong tubercles on the carpus and the ventral surface of the chela. In these species, however, there is no excision in the opposable surface of the dactyl; there is a tubercle or spine on the ischium of the antennal peduncle; both lobes of the proximal podomere of the uropod bear a spine; the rostrum is longer, and the abdomen is longer and much broader; the antennal scale is subquadrate, with a broader lamella; and the annulus is subrhomboidal rather than subovate in outline.

Remarks.—As far as we can determine, the presence of spines or acute tubercles on the ventral keel of the rostrum, while a not uncommon feature in some Malacostraca, has never been reported in freshwater crayfishes except, as mentioned, some Mexican *Procambarus* of the subgenera *Paracambarus* and *Villalobosus*. An investigation of the presence or absence of this character in other U.S. species is just getting underway, but it has to date been found in several other members of subgenus *Depressicambarus*, including *C. (D.) harti*, and in one species of subgenus *Erebicambarus*.

Etymology.—This species is named for both the physiographic province and the county in which it appears to be endemic.

Suggested vernacular name: Dougherty burrowing crayfish.

Cambarus (Depressicambarus) harti
Hobbs, 1981

Some inadvertent errors appeared in the description of this species (Hobbs 1981: 104–109). On page 104, column 2, paragraph 2, part of the first sentence has been omitted. It should read: *Cephalic* lobe of epistome (Figure 45g) subrhomboidal with short cephalomedian projection and scalloped margins; *main body with broad, shallow central depression* lacking distinct fo-

vea. . . . On page 107, column 1, paragraph 1, line 10 says “ventrolateral row of setae on carpus reduced to 2. . . .” This should read: ventrolateral row of *tubercles* on *merus* reduced to 2. The next line says “mesial surface of ischium of cheliped devoid of tubercles,” which should read: mesial *and ventral* surface of ischium. . . . These latter statements (p. 107) apply to the “morphotypic male, form II,” but the specimen actually appears to be a juvenile rather than an adult male of the second form.

Acknowledgments

Our sincerest appreciation is expressed to S. K. Berckman, S. E. Cammack, E. E. Van De Genachte, and M. C. Freeman for assisting CES in the field, to T. S. Patrick for characterizing the vegetation at the type locality, and to G. Henry for providing access to the type locality. The USNM types of *C. (D.) harti* were examined through the courtesy of K. J. Reed and R. Lemaitre. The manuscript was improved by the comments of R. Franz, G. Schuster, C. A. Taylor and R. Lemaitre, and publication was facilitated with funds provided by the Georgia Department of Natural Resources, Wildlife Resources Division.

Literature Cited

- Bouchard, R. W. 1978. Taxonomy, ecology, and phylogeny of the subgenus *Depressicambarus*, with the description of a new species from Florida and redescription of *Cambarus graysoni*, *Cambarus latimanus*, and *Cambarus striatus* (Decapoda: Cambaridae).—Alabama Museum of Natural History Bulletin 3:26–60.
- Erichson, W. F. 1846. Uebersicht der Arten der Gattung *Astacus*.—Archiv für Naturgeschichte 12(1): 86–103.
- Girard, C. 1852. A revision of the North American Astaci, with observations on their habits and geographical distribution.—Proceedings of the Academy of Natural Sciences of Philadelphia 6: 87–91.
- Hay, W. P. 1899. Description of two new species of crayfish.—Proceedings of the United States National Museum 22(1187):121–123.
- . 1902. Observations on the crustacean fauna of Nickajack Cave, Tennessee, and vicinity.—

- Proceedings of the United States National Museum 25(1291):417–439.
- Hobbs, H. H., Jr. 1969. On the distribution and phylogeny of the crayfish genus *Cambarus*. Pp. 93–178 in P. C. Holt, R. L. Hoffman, and C. W. Hart, Jr., eds., The distributional history of the biota of the southern Appalachians, Part I: Invertebrates. Research Division Monograph 1, Virginia Polytechnic Institute, Blacksburg, 295 pages.
- . 1970. New crayfishes of the genus *Cambarus* from Tennessee and Georgia (Decapoda, Astacidae).—Proceedings of the Biological Society of Washington 83(23):241–259.
- . 1972. The subgenera of the crayfish genus *Procambarus* (Decapoda: Astacidae).—Smithsonian Contributions to Zoology 117:1–22.
- . 1981. The crayfishes of Georgia.—Smithsonian Contributions to Zoology 318:1–549.
- LeConte, J. 1856. Descriptions of new species of *Astacus* from Georgia.—Proceedings of the Academy of Natural Sciences of Philadelphia 7:400–402.
- Ortmann, A. E. 1905. *Procambarus*, a new subgenus of the genus *Cambarus*.—Annals of the Carnegie Museum 3(3):435–442.
- . 1906. Mexican, Central American and Cuban *Cambari*.—Proceedings of the Washington Academy of Sciences 8:1–24.
- Villalobos, A. 1955. *Cambarinos de la Fauna Mexicana: Crustacea Decapoda*. Tesis, Facultad de Ciencias, Universidad Nacional Autonoma de Mexico, 290 pp.
- . 1983. Crayfishes of Mexico (Crustacea: Decapoda). Translation of Villalobos 1955 by H. H. Hobbs, Jr. Smithsonian Institution Libraries and National Science Foundation, Washington, D.C., 276 pp.