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Raymond W. Bouchard and David A. Etnier

Abstract.—*Cambarus* (*Depressicambarus*) *deweesae*, a new species of primary burrowing crayfish, is described from the Ridge and Valley province in Anderson and Roane counties, Tennessee (Tennessee River basin). The known localities lie near the foot of Walden Ridge, an escarpment that delimits the eastern margin of the Cumberland Mountains and Cumberland Plateau sections of the Appalachian Plateaus province. Color notes describing its reddish color pattern, relationships with its closest ally *C.* (*D.*) *striatus* Hay, distribution, life history notes and ecological data are presented.

The burrowing habits of North American crayfishes were noted as early as 1817 by Constantine S. Rafinesque in his description of *Cambarus fossor* (suppressed senior synonym of *C.* (*Lacunicambarus*) *diogenes* Girard (1852:88), see Hobbs, 1967:126). The fossorial *Cambarus diogenes* and chimneys marking its burrows were illustrated in the early 1800's by John James Audubon in a portrait of the white ibis. He later included a description of the methodology employed by this bird to extract crayfish from burrows. Despite an early knowledge of burrowing crayfishes (the first epigean species from North America was described by Fabricius in 1798), our knowledge concerning life history aspects and distributions of many primary burrowers remains incomplete. A number of new species of primary burrowers, all with limited ranges, have been described recently (see Hobbs, 1973:463, 469; Hobbs, 1975:24, 28; Schuster, 1976:225; Bouchard, 1978:37), and although many thorough crayfish surveys have been conducted in the southeastern United States and neighboring areas it seems certain that additional species of primary burrowing crayfishes will be discovered here.

Cambarus (*Depressicambarus*) *deweesae*, new species
Figs. 1a–l

Cambarus (*Cambarus*) *diogenes*.—Ortmann, 1931:154, 156, 157 [all in part].

Diagnosis.—Body and eyes with pigment. Rostrum without spines or tubercles. Areola 41.8 to 44.6 percent of total length of carapace (47.2 to 50.5 percent of postorbital carapace length) and obliterated or nearly so with space for no more than 1 punctation. Cervical spines reduced to small,

rounded tubercles; hepatic spines absent; branchiostegal spine present; suborbital angle lacking to obtuse; postorbital ridge moderately strong, rounded cephalically. Antennal scale narrow, longer than broad, broadest slightly distal to midlength. Chela with 2 rows of tubercles on mesial surface of palm, primary row with 6 to 8 tubercles (rarely 9), secondary row with 4 to 6 (rarely 7); opposable margin of dactyl with proximal 4 (rarely 3) tubercles prominent—first and fourth (rarely first and third) larger; corresponding margin of propodus with proximal 2 or 3 tubercles dominant in size, second or third largest; opposable margins of both with single row or irregular double row of denticles; lateral margin costate; lateral base of fixed finger impressed above, less so below. Hook on ischium of third pereiopod of male overreaching basioischial articulation and not opposed by tubercle on basis. First pleopod of first form male with central projection corneous, bladelike, with well-developed subapical notch, recurved at angle of approximately 100°; mesial process tumescent, tapering to 1 or 2 subacute tips and directed caudolaterally at angle of approximately 90° to shaft of appendage. First pleopod of second form male noncorneous; central projection rounded distally; mesial process tapering to acute tip and longer than central projection. Annulus ventralis asymmetrical, subquadrangular, with caudal part somewhat movable; cephalic half elevated and bearing longitudinal median trough between caudally divergent, longitudinal ridges; caudal half with sinuate sinus and elevated caudal wall. First pleopod of female uniramous and reaching approximately midlength of annulus ventralis when abdomen flexed.

Holotypic male, form I.—Body subovate, vaulted (Fig. 1a). Abdomen narrower than thorax (13.7 and 19.9 mm). Greatest width of carapace greater than depth at caudodorsal margin of cervical groove (19.9 and 16.9 mm). Areola obliterated along part of its length and constituting 44.4 percent of total length of carapace (50.5 percent of postorbital carapace length) (Fig. 1k). Rostrum spatulate, deepened cephalically, with slightly convergent, thickened margins devoid of marginal spines or tubercles; upper surface with submarginal punctations and others scattered between. Acumen set off from proximal part of rostrum with concave, oblique margins and terminating in very small, upturned, corneous tubercle. Postorbital ridges moderately strong, deeply grooved dorsolaterally and rounded cephalically. Suborbital angle lacking; branchiostegal spine small (lacking on right side). Cervical spines represented by series of 3 or 4 rounded tubercles; hepatic area and lateral part of branchiostegites tuberculate, especially former; dorsal part of carapace punctate.

Abdomen shorter than carapace (32.4 and 41.4 mm); pleura short with caudoventral extremity broadly angular. Cephalic section of telson with single movable and immovable spines in each caudolateral corner, separated from caudal section by paired oblique excisions. Basal podomere of uropod

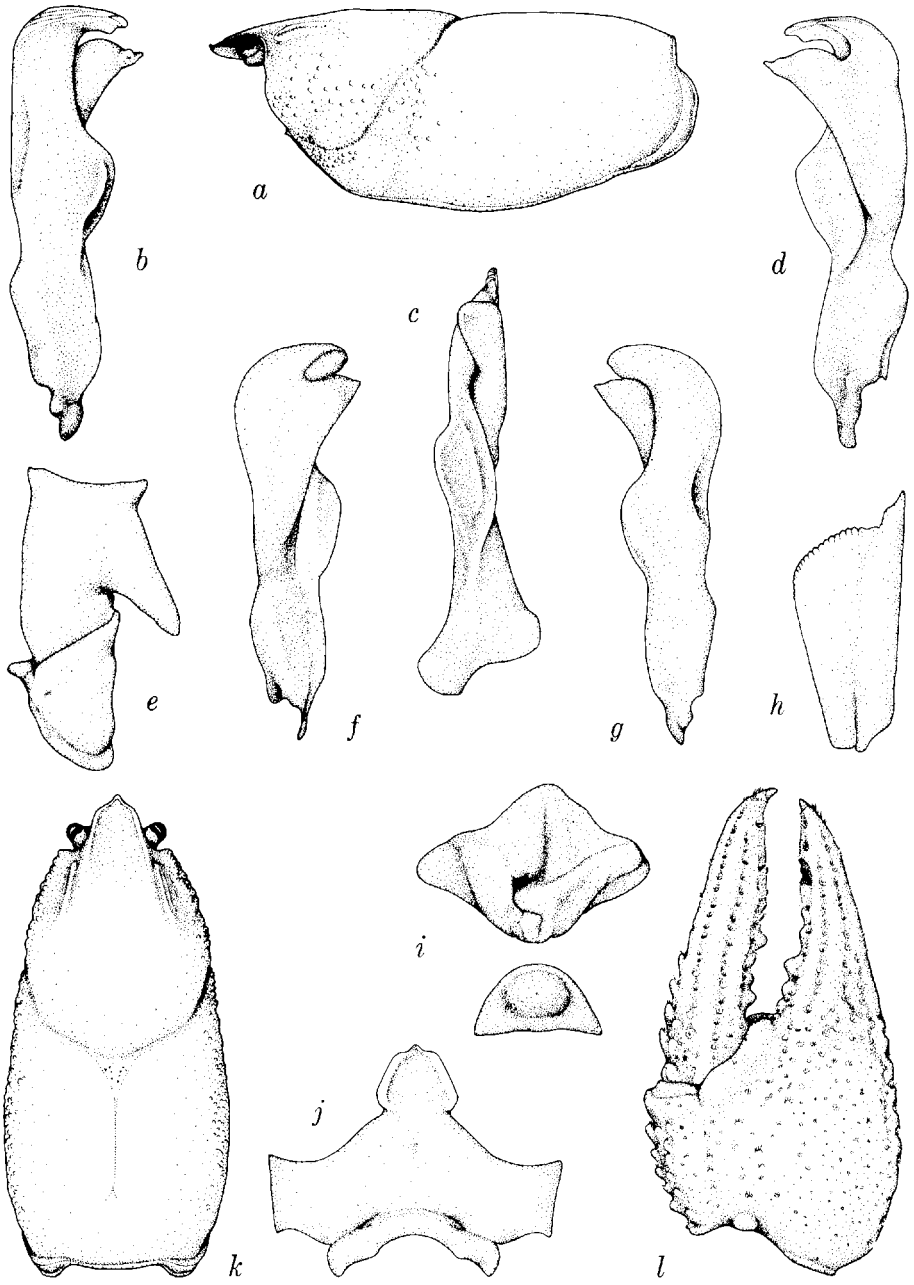

Fig. 1. *Cambarus* (*Depressicambarus*) *deweesae* (**a**, **b**, **c**, **d**, **e**, **h**, **j**, **k**, **l**, holotype; **i**, allotype; **f**, **g**, morphotype). **a**, Lateral view carapace; **b**, **c**, **d**, Lateral, caudal, mesial views first pleopod; **e**, Basis and ischium third pereiopod; **f**, **g**, Mesial and lateral views first pleopod; **h**, Antennal scale; **i**, Annulus ventralis; **j**, Epistome; **k**, **l**, Dorsal view carapace and chela.

with very small spines extending over mesial and lateral rami. Lateral ramus of uropod with median ridge terminating in acute spine at transverse flexure; additional small ridge lateral to median one; proximal part with row of small spines distally and movable spine submarginally at caudolateral corner. Mesial ramus of uropod with median ridge terminating distally in premarginal acute spine. Caudal margin of tail fan with plumose setae; dorsal surface lightly setiferous.

Cephalic lobe of epistome (Fig. 1j) pentagonal with slightly upturned cephalolateral margins and with small cephalomedian projection; ventral surface flattened. Basal part of epistome with deep, median fovea and pair of obliquely disposed, slitlike fossae immediately cephalic and subparallel to thickened, arched, short epistomal zygoma; lateral extremities without tubercles. Proximal segment of antennule with small spine on ventral surface at base of distal fourth. Antennae extending to fifth abdominal segment. Antennal scale (Fig. 1h) narrow, broadest slightly distal to midlength; thickened lateral part terminating in acute, corneous-tipped spine (broken on left) projecting forward but not reaching tip of rostrum; lamellar area narrow, with mesial margin angulate, crenulate and edged with long, plumose setae.

Right chela (Fig. 1l) approximately 2 times longer than broad (27.9 and 15.0 mm), well depressed, although slightly inflated proximolaterally; mesial margin of palm with 2 rows of 6 tubercles each in primary and secondary rows; dorsal surface bearing several small squamous tubercles over mesial half of palm. Lateral surface of propodus costate with row of punctations rendering proximolateral margin of fixed finger and palm irregular in dorsal aspect. Fixed finger with proximolateral base impressed dorsally, less so ventrally; dorsal and ventral surfaces with distinct submedian ridges flanked by setiferous punctations; opposable surface with row of 5 tubercles along proximal three-fifths of finger, third largest, decreasing in size proximally; additional small tubercle (absent due to injury on right) present on lower level at base of distal third, and double row of minute denticles extending proximally from corneous tip of finger to third tubercle from base, interrupted by fourth and fifth. Dorsal and ventral surfaces of dactyl with median longitudinal ridges flanked by setiferous punctations; opposable margin with row of 8 tubercles, first and fourth larger; mesial margin of dactyl tuberculate along nearly proximal half and punctate along distal half; double row of minute denticles extending from corneous tip to fourth tubercle from base, interrupted by fifth through eighth.

Carpus longer than broad with deep, oblique furrow dorsally; mesial surface with large procurved spine near midlength and with cluster of 5 smaller tubercles situated ventrad of it and additional single one proximally; distoventral margin with strong spiniform tubercle and smaller, proximally disposed one; podomere otherwise punctate.

Dorsodistal surface of merus with 4 subacute tubercles and irregular row

of 9 along crest of podomere; ventral surface with lateral row of 6 tubercles, some corneous-tipped, and mesial row of 12 corneous-tipped, acute tubercles, both rows decreasing in size proximally. Ischium with 2 very small tubercles on mesial margin.

Hook on ischium of third pereiopod only (Fig. 1e); hook simple, overreaching basioischial articulation and not opposed by tubercle on basis. Coxa of fourth pereiopod with prominent caudomesial boss; fifth pereiopod without prominence. For measurements see Table 1.

First pleopods (Fig. 1b, c, d) reaching caudal part of coxae of third pereiopods when abdomen flexed. See "Diagnosis" for description.

Allotypic female.—Differing from holotype in following respects: suborbital angle slightly more angulate. Cephalic part of epistome with more angular cephalolateral margins. Cervical spines represented by 2 or 3 dominant tubercles on each side. Chela with primary row of tubercles on mesial margin of palm consisting of 8 and 7 on right and left ones, respectively; secondary row of both with 5. Opposable margin of right propodus with row of 7 tubercles (8 on left), and single to double row of denticles extending proximally from corneous tip to fourth tubercle on left cheliped, interrupted by fifth through seventh tubercles (fourth through sixth on right). Opposable margin of dactyl with 10 and 12 tubercles on right and left chelipeds, respectively, fourth largest, and single row of denticles extending proximally from corneous tip to sixth tubercle on right cheliped (fifth on left), interrupted by seventh through tenth and sixth through eleventh tubercles on right and left fingers, respectively. Right carpus with cluster of 8 tubercles (7 on left) near large procurved spine on mesial margin. Merus with 9 tubercles along crest of podomere; ventral surface with 9 tubercles in lateral row and 13 in mesial one. Ischium with row of 4 small tubercles on mesial margin.

Annulus ventralis (Fig. 1i) subquadrangular, broader than long and situated deep in sternum with cephalic part fused to sternum and caudal half somewhat movable. Annulus ventralis divided by sinus into C-shaped and triangular parts, latter with basal tongue projecting into concavity of "C." Cephalic half elevated and bearing sinus broadening into median, longitudinal trough flanked by caudally diverging ridges; caudal portion elevated and nearly bisected by shallow sinus. Postannular sclerite approximately half as wide as annulus, with oval elevation (ventrally) almost one-third width of annulus.

Morphotypic male, form II.—Differing from holotype in following respects: rostrum with margins less angulate cephalically; apical tubercle worn and barely visible. Cervical spines consisting of 2 dominant tubercles on right side, 1 on left; suborbital angle slightly more angulate; antennal scale moderately wide. Chela with primary row of 7 tubercles on mesial margin of right palm, secondary row of both with 4. Opposable margin of right

Table 1. Measurements (mm) of *Cambarus* (*Depressicambarus*) *deweesae*.

	Holotypic Male, Form I	Allotypic Female	Morphotypic Male, Form II
Carapace			
Height	16.9	18.2	****
Width	19.9	21.5	****
Total length of carapace	41.4	44.5	****
Postorbital carapace length	36.4	38.9	****
Areola			
Width	*	*	****
Length	18.4	19.0	****
Rostrum			
Width	5.4	5.7	4.6
Length	5.0**	5.6**	****
Chela			
Length, mesial margin of palm	9.3	9.6	6.7
Width, palm	15.0	14.7	10.6
Length, lateral margin	27.9	29.4	***
Length, dactyl	18.3	***	14.4

* Areola obliterated.
** Measurement after Bouchard, 1973:103.
*** Distal tubercle broken.
**** Carapace pliant and wrinkled.

propodus with row of 7 tubercles (6 on left), and row of denticles extending proximally from tip to sixth tubercle on right cheliped, interrupted by seventh (extending to fifth and interrupted by sixth on right). Opposable margin of dactyl with 11 tubercles on each cheliped, and single row of denticles extending proximally from corneous tip to fifth tubercle on right cheliped, interrupted by sixth through eleventh (interrupted by fifth through eleventh on left cheliped). Right carpus with cluster of 11 tubercles (13 on left) near large procurved spine on mesial margin. Merus with 9 and 12 tubercles along crest of right and left podomeres, respectively; ventral surface with 7 tubercles in lateral row and 13 in mesial one of both chelipeds.

Hook on ischium of third pereiopod much reduced, not reaching basiischial articulation, and not opposing tubercle on basis; boss of coxa of fourth pereiopod somewhat smaller and less sharply defined. First pleopods (Fig. 1f, g) of uniform texture and reaching caudal portions of coxae of third pereiopods when abdomen flexed. See "Diagnosis" for description.

Color notes.—Cephalothorax and abdomen concolorous, ranging from bright red or orange red to more somber brick red dorsally. For brevity range of red hues referred to as reddish. Gastric region and abdomen bright-

er than hepatic area and former with paired, mottled areas marking attachment of mandibular muscles. Branchiostegites and hepatic areas concolorous reddish dorsally, fading to white ventrad. Pleural regions of abdomen reddish, cream or white ventrally and may bear paired light spots on first segment. Ventral aspects of cephalothorax and abdomen white. Rostral margins and postorbital ridges yellow or same color as cephalothorax. Tubercles, spines and articular condyles yellow or cream. Antennal scale reddish, lateral margin darker than lamellar portion. Antennae reddish to brown.

Chelae reddish with lighter proximolateral area; white ventrally. Distal ends of fingers yellow to cream or reddish. Pereiopods light reddish to pink dorsolaterally; white ventrolaterally. Distal podomeres darker dorsally than proximal ones.

Ortmann (1931:157) noted the color of this species as follows: ". . . at the eastern foot of Walden Ridge, at Harriman and Dossett, all specimens found (2 ♂ II, 1 ♀) had a *reddish* ground color. While the female from Dossett has been recorded as completely 'bright red,' the males from Harriman are recorded as, 'body olive-brown to reddish-brown (on carapace); rostrum and chelae orange-red; sides of carapace pale grayish-olive.' "

Type-locality.—Seepage area near east bank of Poplar Creek at Tennessee State Highway 61 (south side of highway) in Anderson County, Tennessee. This locality lies within the Clinch River system (Tennessee River basin). Collected with *C. deweesae* from burrows at the type-locality was *C. (Cambarus) bartonii* (Fabricius, 1798:407).

Disposition of types.—The holotypic male, form I (no. 148363) and the allotypic female (no. 148364) are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A. The morphotypic male, form II (no. 74.1092) is on deposit at the Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, U.S.A. Paratypes consisting of 5♀ are in the Smithsonian Institution, 1♂ II and 1♀ in the Carnegie Museum and 1♂ I, 3♀, 1♂ juvenile, 1♀ juvenile and 1♀ bearing eggs are in the collection of the senior author.

Range and specimens examined.—This crayfish is known from four localities in a small area of Anderson and Roane counties, Tennessee, within the Clinch (Anderson County) and Emory (Roane County) River systems (Tennessee River basin). These localities lie near the foot of the eastern escarpment (Walden Ridge) of the Cumberland Mountains and Cumberland Plateau sections of the Appalachian Plateaus province in the Ridge and Valley province. Other primary burrowers that occur in the Ridge and Valley are *C. (Jugicambarus) dubius* Faxon (1884:114), *C. (Depressicambarus) striatus* Hay (1902:437), *C. (D.) cymatilis* Hobbs (1970:241), *C. (L.) diogenes (sens. lat.)* and an undescribed *Cambarus* of the subgenus *Lacunicambarus*. *Cambarus bartonii*, regarded as a tertiary burrower (see Bou-

chard, 1976:588), has been collected from burrows some distance from surface waters, and is the only species collected with *C. deweesae* to date.

TENNESSEE—ANDERSON COUNTY—(i) Type-locality. IV/20/71. D. A. Etnier and J. P. Dewees, coll. 5♀; (ii) Type-locality. III/13–16/72. D. A. E. and F. L. Oakberg, coll. 2♂I, 2♀, 1♀j, 1 ovigerous ♀; (iii) Swamp, Dossett (foot of Walden Ridge). IX/2/14. A. E. Ortmann, coll. 1♀. ROANE COUNTY—(iv) Field between County Road 2437 and Tennessee State Highway 61, west of the town of Little Emory. I/25/71. D. A. E., coll. 1♀, 1♂j; (v) Harriman (foot of Walden Ridge). V/16/15. A. E. O., coll. 2♂II.

Variations.—The small number of specimens available exhibit little variation other than the usual expected range in meristics and abrasion of spines and tubercles in late intermolt stages.

Size.—The largest specimen available is a female with a carapace length of 48.0 mm (postorbital carapace length 42.0 mm). The smallest first form male has corresponding lengths of 41.3 and 36.8 mm. The largest first form male has a carapace length of 41.4 mm (postorbital carapace length 36.4 mm). The only female specimen collected with eggs has a carapace length of 46.4 mm (postorbital carapace length 41.3 mm).

Life history notes.—Form I males were collected in March 1972 between the thirteenth and sixteenth of the month (exact date unknown), and a single ovigerous female was collected during this same period.

Ecological notes.—*Cambarus* (*D.*) *deweesae* is a primary burrower. A label accompanying the crayfish collected by Ortmann from Dossett indicates this individual to have been collected from a swamp. All of Ortmann's specimens were "dug out of holes" (1931:155).

The type-locality is a poorly drained floodplain on the east side of Poplar Creek and on the south side of Tennessee State Highway 61, Anderson County, Tennessee. Soils consist of clays interspersed with fragments of shale. Burrows are complex and variable, with much of this variability attributable to obstructions presented by large shale fragments. Typical burrows consist of a conspicuous opening surrounded by excavated clay. Well-defined chimneys have not been observed. The shaft leading from this opening is vertical or nearly so. One to several short, horizontal culs-de-sac often extend from the vertical shaft approximately 5 to 20 cm below the soil surface. At a depth of 50 to 70 cm the vertical shaft begins to assume a more horizontal position. Often the burrow bifurcates at this depth, with one of the resulting more horizontal galleries a cul-de-sac and the other angling back toward the surface. The opening of the latter branch is well concealed under vegetation, may have a short, horizontal, blind chamber near the surface and lacks excavated material around the opening. Digging the entire burrow system is a tedious but effective method of collecting specimens. Often individuals can be obtained by using a plunging motion with an extended forearm. Displaced water can be heard gurgling to the surface at the site of the concealed opening, and the resident of the burrow may be dis-

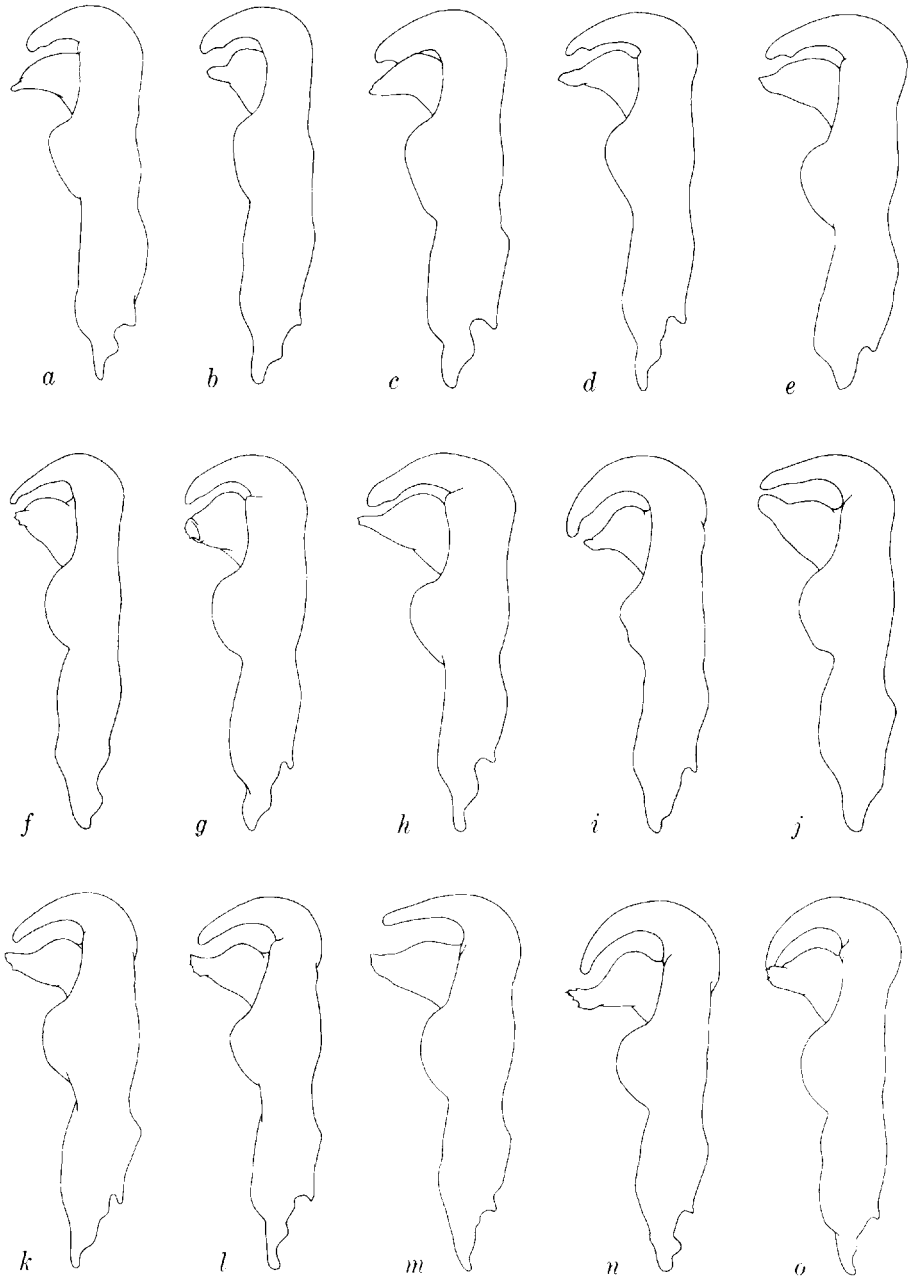

Fig. 2. *Cambarus (Depressicambarus) striatus*, lateral views of left first pleopod, male, form I: **a–b,** Winston Co., MS; **c,** Dawson Co., GA; **d,** Montgomery Co., TN; **e,** Loudon Co., TN; **f,** Coffee Co., TN; **g,** Blount Co., AL; **h,** DeKalb Co., AL; **i,** Marion Co., AL; **j,** Lafayette Co., MS; **k,** Bledsoe Co., TN; **l,** Henderson Co., TN; **m,** Tuscaloosa Co., AL; **n,** Macon Co., AL; **o,** Lee Co., AL.

placed to the mouth of the concealed opening. A burrow is typically occupied by a single animal, but the high population density occasionally results in adjacent burrows being connected by heavily silted, horizontal tunnels that are presumably little used.

Although considerable construction and filling has recently taken place near the type-locality, this crayfish was still thriving in March 1978. Much of the area will become incorporated into a golf course that is currently under construction. Since burrowing crayfish are typically compatible with most areas of golf courses, the continued survival of this species at the type-locality seems certain.

Relationships.—Cambarus deweesae is a member of the subgenus *Depressicambarus,* exhibiting a broadly subtriangular and depressed chela with two major rows of tubercles along the mesial margin of the palm, a common feature of the group. Within this subgenus *C. deweesae* bears closest affinities to members of the *latimanus* group (Bouchard, 1978:44) and in particular *C. striatus* Hay, a wide-ranging and variable species adapted to a broad array of habitats. *Cambarus striatus* occupies epigean waters as well as burrows as a primary, secondary or tertiary burrower (Bouchard, 1976:591, slightly modified from Hobbs, 1942:20).

The most distinctive differing features between the two species are the first pleopod of the first form male and the annulus ventralis of the female. In *C. deweesae* the central projection of the gonopod is short, tapered and bears a subapical notch, a combination of features not known from any population of *C. striatus* (*cf.* Fig. 1b and Fig. 2). In the female of *C. deweesae* the cephalic part of the annulus ventralis is elevated while in *C. striatus* the cephalic part is distinctly lower in height than the caudal wall. An elevated cephalic part of the annulus ventralis is also found in members of the *halli* group of the subgenus and in particular in *C. obstipus* Hall and populations of *C. englishi* Hobbs which occur syntopically with *C. halli* Hobbs.

The areola of *C. deweesae* is obliterated or very narrow with space for no more than one punctation while in *C. striatus* the areola is rarely obliterated and usually slightly wider. The suborbital angle in *C. deweesae* is lacking or poorly developed, while it is generally moderately well developed in *C. striatus*. The reddish color pattern of *C. deweesae* is unknown in populations of *C. striatus,* a species which basically exhibits a color pattern consisting of browns and greens, although occasional individuals with blue or blue-gray colors have been observed (see Bouchard 1978:42).

Within the subgenus *Depressicambarus* the reddish color of *C. deweesae* also occurs in *C. pyronotus* Bouchard (orange-red, Bouchard, 1978:39) and has been observed rarely in *C. graysoni* (*op. cit.*). *Cambarus pyronotus* like *C. deweesae* exhibits a reduced suborbital angle (obsolete in *C. pyronotus*). Both species occur at the periphery of the range of *C. striatus—C. pyro-*

notus in Torreya Ravine, Liberty County, Florida, and *C. deweesae* in Anderson and Roane counties, Tennessee, near the foot of Walden Ridge.

Joel Palmer Dewees
1943–1977

Etymology.—We are pleased to name this new species of crayfish in honor of the late Joel P. Dewees (1943–1977), whose interest in burrowing crayfishes has enriched our knowledge of many species in the Appalachian Plateaus province and southern parts of the Ridge and Valley and Blue Ridge provinces. Miss Dewees also assisted in the collection of material from the type-locality.

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