

FIGURE 7—*Cyclus americanus* Packard. Reconstruction of dorsal surface. Scale = 2 mm.

3 segments: a short basal one and two longer more distal articles. The last of these carry a short flagellum (PE 20985, Figure 2.1; Figure 8.2).

The small and delicate mouth parts occur on only a few specimens. The small labrum displays a somewhat triangular structure (PE 34763, Figure 3.3; Figure 8.3). Just posterior to these, the mandibles (Figure 8.4) appear as blades (PE 22472, Figure 3.4; MCP 557, Figure 4.4). Whether these bore palps can not be determined.

What appears as the small maxillules (Figure 8.5), lie just posterior to the mandibles, and each bear a pronounced, reflexed palp. The small basal segment (PE 22498, Figure 3.2) carries a long article, which in turn distally connects to another long segment directed medially and posterior, effectively bending back on the proximal segment (MCP 557, Figure 4.4).

The large, robust maxillae (Figure 8.6) apparently could collapse on themselves, like multiple-jointed jackknives, but they frequently extend beyond the anterior edge of the rostral plate (PE 24959, Figure 3.1; MCP 507, Figures 4.1, 4.2). The terminal segment, shaped like a scimitar (PE 22421, Figure 5.1, PE 31713, and PE 15167), apparently bears robust setae on its medial terminus and flexes against a large, blade-like, penultimate segment with large setae on its medial margin (PE 34940, PE 34954, Figure 5.2) to form a geniculate claw or clasper. Proximal to the claw, two short segments connect to a very long segment (PE 22421, Figure 5.1) that in turn may articulate with a short basal-most segment.

The first pair of thoracopods, or maxillipedes (Figure 8.7), greatly resemble the geniculate maxillae (PE 34954, Figure 5.2). The maxillipedes, like the maxillae, also were capable of extending anteriorly beyond the edge of the front of the head. The geniculate claw is somewhat larger than that seen on the maxilla (PE 34954, Figure 5.3) and bears more robust setae on the penultimate blade-like segment. Two intermediate segments connect the geniculum to a long proximal segment (PE 1280,

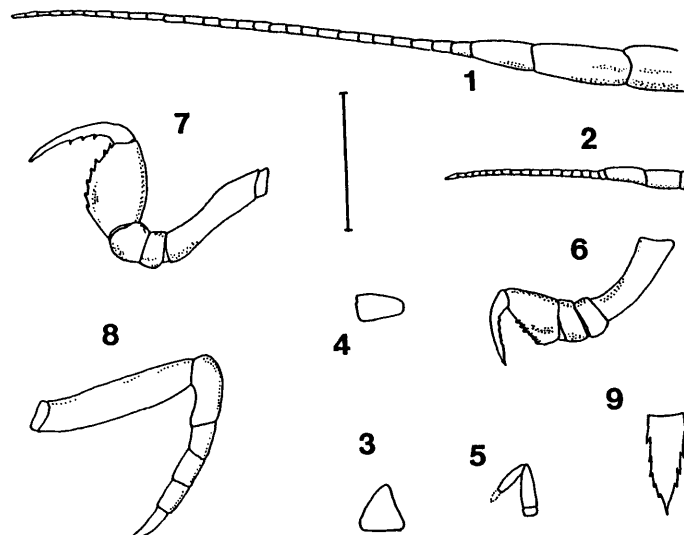


FIGURE 8—*Cyclus americanus* Packard. Reconstruction of appendages and associated structures: 1, antennule; 2, antenna; 3, labrum; 4, mandible; 5, maxillule; 6, maxilla; 7, maxillipede; 8, thoracic walking leg; 9, caudal ramus. Scale = 2 mm.

PE 22472, Figure 3.4), which in turn seems to attach proximally to a very short, ring-like segment.

Thoracopods two through six, virtually identical, tend to become somewhat shorter posteriorly in the series. Although we examined almost 900 specimens from several museum collections in this study, of these we found that very few preserve the thoracopods adequately (e.g., PE 22495, Figure 6.3; PE 34759, Figures 5.4, 5.5; PE 34954, Figure 5.2). These limbs apparently all articulate on the margin of the thoracic sternites. It is not clear whether a very long, often medially directed, proximal segment attaches directly to the sternites. Some evidence seems to indicate in this regard that a small ring-like article (PE 22478, Figures 6.1, 6.2) connects this long segment to the sternite. (Indeed, the dynamics of movement possible around the thoracopod/sternite joint would seem to require a small "coaxial" segment.) The distal end of the long segment marks a knee in the thoracopods (Figure 8.8), and five moderate to short segments compose the distal aspect of the thoracopod (Figures 5.4, 5.5).

The abdomen possesses two segments, a short anterior one, which bears a pair of large papillae laterally (PE 22495, Figure 6.3), and a somewhat larger posterior segment exposed dorsally by the median posterior carapace notch. This last segment bears the anus as well as the marginally serrate (PE 22421, Figure 5.1) caudal rami (PE 22495, Figure 6.3).

*Occurrence.*—Francis Creek Shale, Desmoinesan, Middle Pennsylvanian.

*Material examined.*—USNMP 38863. Some 876 specimens in the fossil invertebrate collections of the Field Museum of Natural History, but especially PE 15167, 15191, 20601, 20616, 20985, 21013, 22421, 22444, 22462, 22472, 22478, 22495, 22498, 23397, 24949, 24959, 31712, 31713, 32159, 32173, 34940, 34759, 34763, 34791, 34797, 34822, 34842, 34925, 34935, 34954. MCP 452, 507, 554, 555, 556, 557, 558.

*Holotype.*—USNMP 38863 (Figures 1.1, 1.2); from along Mazon Creek, Grundy County, Illinois.

*Remarks.*—We offer a reconstruction of the dorsal aspect of *C. americana* in Figure 7 and our interpretation of the appendages in Figure 8.

A problem exists regarding the identity of the antennules and

TABLE 1—Size in cm of a representative array of 55 well-preserved specimens *Cyclus americanus* in the collections of the Field Museum of Natural History.

	Carapace		
	Length	Width	Length : width
Range	0.96–2.02	0.90–2.0	
Av. length	1.40	1.43	0.98
St. dev.	0.23	0.27	
St. error	0.03	0.04	

antennae. Although the large size of the anterior-most limbs might suggest antennae, we denoted these long limbs as the antennules, initially only because of their location. We thus identified the much shorter and somewhat more posterior limbs as the antennae. Clark (1989), however, believed that the opposite was true based on his work with *Cyclus rankini*, viewing the large limbs as the antennae and the smaller ones as the antennules. Although antennules generally occur as the smaller of the two limbs in crustaceans, in many groups just the opposite prevails. This in fact commonly happens within the Maxillopoda, as within many copepod orders, the branchiurans, and the mystacocarids. Huys and Boxshall (1991) have advanced a new interpretation of copepod evolution in which they hypothesized that antennules had in their most plesiomorphic state 28 segments—virtually identical to what we found on those limbs we identify as the antennules of *Cyclus*. So, Clark notwithstanding, we hold to our original designation.

These fossils can preserve internal soft-part anatomy. The gut often occurs as a detritus-filled cast (e.g., see Figures 1.2, 1.4, 3.1, 4.5, 4.6). Occasionally, one can discern a somewhat wider anterior region of the gut. In one particular specimen (PE 20601, Figure 6.4), this transition appears not only as a change in gut diameter, but also as a difference in gut content. The foregut in this specimen (the anterior, wider region) contains slightly coarser sediment than the midgut (the posterior, narrow region) and, when examined under alcohol, this specimen appears to preserve pyritized remnants of the foregut dilator muscles associated with that region. *Cyclus americanus* is the most common of the cycloids in the Mazon Creek biotas. Of the 876 specimens in the collections of the Field Museum examined for this study, all of them came from the Peabody Coal Company, Pit 11 mine, in Will and Kankakee counties, northeastern Illinois. This is the principle collecting site for the marine-like Essex fauna. The holotype specimen that Packard described from the Lacoe Collection had to have come from the fresh- to brackish-water Braidwood fauna localities along Mazon Creek itself, the principal source of classic Mazon Creek specimens in the last century. However, one hardly ever sees examples of *Cyclus* in any of the Braidwood fauna collections examined by many researchers over the years. This would indicate that, although *Cyclus* could have occurred in the Braidwood habitat, in life *Cyclus americanus* preferred more marine conditions.

Some question has arisen in the literature as to what *Cyclus* fed upon. The loosely stated consensus of past workers has more or less opted for some kind of parasitic mode, based mostly on the gross similarity of cycloids to branchiuran fish lice. However, the relatively large size of *Cyclus* argues against a parasitic habit (at 1 cm in diameter these purported parasites match in size many of the fish in the fauna they supposedly would have fed upon). On the other hand, the only consistent association within the Mazon Creek concretions of *Cyclus*, other than with other examples of itself, occurs with plant material (e.g., see Figures 6.1, 6.2). Such associations inevitably have the plant material lying close to or attached to the head. The geniculate claws and slicing mouth parts not only could have served a parasite, but also could have provided equally good service to a plant or detritus eater. We believe this latter possibility much more likely than parasitism.

CYCLUS OBESUS new species  
Figures 9, 10

*Diagnosis.*—Carapace oval in outline, much wider than long, surface smooth bearing no decoration, margin demarcated by a narrow shelf, edges smooth and entire (no posterior notch), central region of carapace shield elevated as a plateau and delineated by a pronounced circular ridge.

*Description.*—*C. obesus* possesses a strikingly wide carapace (see Table 2), with a surface not marked with any textured decoration (PE 30630, Figure 9.2), but with a margin set off by a narrow brim or shelf. The central area is flattened, higher than the margin and set off by a distinct circular ridge (PE 23041, Figure 9.3). The cephalon has a very wide frontal extension or rostral plate, and the area of the carapace just posterior to the antennular bases bears a slight, raised, ocular ridge (PE 23041, PE 30630, Figure 9.1, 9.3). The carapace displays neither posterior median nor anterolateral ocular notches.

The large and very long antennules (PE 34834; PE 34880, Figure 9.5) possess a basal peduncular segment of moderate length, slightly longer than wide. The second peduncular segment appears shorter than the first. Presently we have little knowledge concerning the rest of the limb.

We know nothing about the labrum, mandibles, or maxillules. The geniculate maxillae have a robust, club-like, terminal segment that folded back onto a rather wide penultimate segment (PE 39056, Figure 9.4). We have no knowledge about the rest of the limbs.

The caudal rami appear as long blade-like processes on only a single specimen (PE 34834, not illustrated).

The thoracic tergites have a subparallel, largely laterally directed, linear arrangement and express only a slight posteriad orientation (PE 34880, Figure 9.5).

*Occurrence.*—Francis Creek Shale, Desmoinesan, Middle Pennsylvanian.

*Material examined.*—PE 23041, 24975, 30630, 34834, 34880, 39056.

*Holotype and locality.*—PE 30630 (Figure 9.1, 9.2), Peabody Coal Co. Pit 11, Will and Kankakee counties, Illinois.

*Remarks.*—We present a reconstruction of the dorsal aspect of *C. obesus* in Figure 10.

A few specimens of *C. obesus* (notably PE 39056, Figure 9.4, PE 34880, Figure 9.5) preserve gut casts. However, the gut appears to terminate in a position relatively more anterior to that seen for the position of the anus of *C. americanus*.

The arrangement of the thoracic segments differs from that of *C. americanus*. Rather than “radiating” out from an area somewhat posterior to the center of the cephalothorax, they have a somewhat more linear and subparallel array, with the posterior deflection not nearly as pronounced as that seen in *C. americanus*. Thus, the thorax, wide like the carapace, may accommodate the short abdomen such that the terminus of the abdomen may lie well beneath the carapace.

The lack of a posterior median notch on the carapace shield distinguishes *C. obesus* from what is known of other species of *Cyclus*. However, the relatively flattened shape of the body, the character of the geniculate maxillae, the prominence of the frontal extension, and the nature and orientation of the antennules, resemble the better known *C. americanus* and *C. rankini*. The above features would seem perhaps more diagnostic at a family rather than a generic level, and some future revision of the cycloids may place *C. obesus* into a separate genus.

Genus HALICYNE von Meyer, 1844.

*Diagnosis.*—Carapace with moderately convex and shield-like outline distinctly truncated anteriorly and either slightly acute or distinctly pointed posteriorly, with distinct optic notches, anteriorly articulated to a separate rostral plate; geniculate maxillae modest to small in size; first two thoracopods at least modified as maxillipedes; post-maxillipedal thoracic legs directed laterally and anteriorly; underside of carapace in the thoracic region marked by densely packed transverse rugae or lamellae.

*Type of genus.*—*Limulus agnotus* von Meyer, 1838.