Clarke’s Bugs

The Abundant Scud

by Clarke Garry

It's typically a warm fall day when I'm leading my entomology class down to the Kinnickinnic, D-nets in hand, for the collecting portion of our riffle-based biotic indexing lab series. Many of these students have heard about the mayflies, stoneflies, and caddisflies they might encounter, but they don't yet appreciate the fact that the greatest percentage of any single species or group they will be collecting will be scuds. The idea that scuds can be ". . . unbelievably abundant" (Pennak 1978) or ". . . startlingly abundant" (Borger 1980) is accurately descriptive for a large part of the Kinni watershed year around.

This uniquely common macroinvertebrate in the Kinnickinnic River and its tributaries is *Gammarus pseudolimnaeus* (Crustacea:Amphipoda), commonly known as the scud, sideswimmer, or freshwater shrimp. The species was named by Bousfield when he revised the freshwater amphipods inhabiting previously glaciated regions of North America (Bousfield 1958). *G. pseudolimnaeus* is widely distributed throughout the Great Lakes region and it is likely that our location in west-central Wisconsin is near the northernmost edge of its distribution.

G. pseudolimnaeus appears to be the single species of scud in the Kinni, as supported by examination of ~800 specimens acquired in my 1999 macroinvertebrate survey of the river. All 17 river collection sites sampled over a nearly complete calendar year from Kinnickinnic State Park to north of Interstate 94 yielded specimens of this species. Additionally, in biotic indexing sampling that I carried out in the South Fork between March and May of 2000, this scud composed up to 90.2% of macroinvertebrates collected (Garry, *unpublished data*). By the way, for use in his biotic indexing (BI) protocol, Hilsenhoff (1987) provides *G. pseudolimnaeus* with a tolerance value of 4. On a ten point scale (0=excellent, 10=very poor) a hypothetical BI collection of 100% of this species would rate as "Very Good" and be representative of water with only "possible slight organic pollution."

As an amphipod crustacean, this creature appears quite different from the many and diverse insects of the Kinni. The shrimp-like body is arched (when not swimming) and laterally-flattened. Two pairs of antennae extend forward from the head, and nineteen serially-arranged, paired appendages are apparent. These include six pairs of mouthparts, two gnathopods (grasping legs), five pereopods (crawling legs), three pleopods (swimming legs), and three uropods (more-or-less-fixed abdominal legs). Technical identification of this species requires, among other things, enough magnification to see the concave posterior margin of the base of the 5th pereopod (crawling leg) and long setae (bristles) also along this margin (Holsinger 1972). Scuds appear in a variety of colors based on gray or tan; sometimes they are subtly orange, purple, blue, or green. Pennak (1978) proposed that color may be dependent on diet, temperature, or age of the individual.

Scuds are fast swimmers often seen dashing from place to place in shallow water. The very name "scud" (*v. i.*, to move or run swiftly) suggests this quick movement. Scuds inhabit benthic vegetation and debris in shallow water and are therefore readily collected by kick sampling. Pennak (1978) comments that as a group, ". . . the amphipods are cold stenotherms, strongly thigmotactic, and react negatively to light." This translates as adaptation to a narrow, cold temperature range, an instinctive need to be in contact with a substrate, and hiding behavior in vegetation, debris, and stones during daylight. When collected live and brought into the lab, they readily position themselves under any cover present, and only occasionally are observed darting from one hiding location to another. They are active at night in the stream and their presence as part of the nocturnal behavioral drift phenomenon has been well documented (Waters 1972). Scuds are occasionally observed with the males carrying the females on their backs, a behavior recognized as pre-copulatory pairing. This is, of course, a great conversation starter when samples are brought in to a local 4th grade class as part of an aquatic biodiversity demonstration!

Scuds are omnivorous scavengers. They are, in turn, preyed upon by insects, amphibians, birds, and fish with the latter being their chief predators. McCafferty (1981) notes that scuds are an important food source for fish and Borger (1980) comments, in reference to their large numbers, that it's ". . . little wonder they're fed upon by trout."

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The Naked Caddis

by Clarke Garry

Pick up almost any rock from the bottom of the Kinni and one will discover a dark, olive-green, worm-like creature crawling on the underside. This larva could be any of several species of netspinning caddisfly immatures. What makes these larvae especially noteworthy, beyond their obvious numbers, is that they lack the case typical of the majority of caddis species. Netspinners are members of the order Trichoptera, family Hydropsychidae. The family name translates from its Greek origins as "water spirit," although some translations would have it as "water butterfly."

The netspinners account for four of the 20 known species of caddisflies in the Kinnickinnic River. The most common of the 1272 hydropsychid specimens collected in my 1999 Kinnickinnic benthic inventory were: *Ceratopsyche slossonae* (33% of total caddisfly larvae collected), *Ceratopsyche alhedra* (22%), and *Ceratopsyche alternans* (4%). [For quantitative comparison the next most common kind of caddis collected in the inventory was the humpless casemaker, *Brachycentrus occidentalis*, representing an additional 23% of the Trichoptera.] *C. alhedra* and *C. alternans* tolerate water with only the slightest organic enrichment; these have tolerance values of 3 (based on a ten point scale, 0=excellent, 10=very poor) (Hilsenhoff 1987). *C. slossonae* (tolerance value = 4) can apparently survive in streams with moderate amounts of organic matter. And that brings up a very interesting point. Based on the 1999 dataset, *C. slossonae* is found in the Kinni from Kinnickinnic State Park and 15 of 16 additional evenly-spaced collection sites ending just north of I-94. Collection records of *C. alhedra* and *C. alternans* begin in the park and progress upstream only as far as Site 9 (Quarry Road bridge area). One must be cautious with negative data, but no collections of the latter two species have yet been made in the 8 sites upstream from this point. This distribution pattern has similar examples in certain mayflies and stoneflies.

Take a closer look at these larvae and one sees a strongly curving body with three pairs of thoracic legs and a pair of prolegs on the last abdominal segment. The prolegs have a distinctive tuft of hairs arising from them. Each of the three thoracic segments is covered dorsally with a dark, protective plate, a characteristic, along with numerous branched, ventral, thoracic and abdominal gills, that separates this caddisfly family (in the larval stage) from others.

The three common species of netspinners can be separated from each other by various patterns of light markings on the brown background of the head capsule. *C. slossonae* can be very distinctive with a single median yellow spot on its head. However, some of them (the "dark form" of *C. slossonae*) have a uniformly dark head as pointed out to me by Guenter Schuster and David Etnier, two well-known hydropsychid authorities, at the 1999 North American Benthological Society Meeting last year, when I showed them an array of Kinni netspinners. *C. alhedra* is distinctive because of a pair of light patches in a side-by-side pattern midway down the front of the head. And *C. alternans* is a classic "checkerboard" species with numerous intermixed light and dark areas on the head.

These caddisflies construct a fine-meshed silken catchnet attached to a rock or piece of woody material and oriented to the current. This net functions to collect suspended organic food materials including debris, various invertebrates, algae, and diatoms (Schefter and Wiggins 1986). Next to the net the larva lies concealed in a spun silken retreat, camouflaged with sand or organics, from which it exits to feed on filtered materials. The worm-like larval stage molts several times, progressively increasing in size. The pupa is then transformed to an adult within its reinforced retreat. Exiting from the case is the pharate adult (still in a pupal cover) heading for the surface to emerge. This emergence behavior, and the return of the females to the water to lay eggs, make these life stages particularly vulnerable to feeding trout.

Dr. Ralph Holzenthal of the University of Minnesota estimates that any given watershed in Minnesota or Wisconsin may have 50 to 75 species of caddisflies, as determined by adult collections. Therein lies the key to further understanding this fauna, a systematic collection of adults. The author has an adult study planned for the Kinnickinnic Watershed based on portable UV (blacklight) attraction. This will, additionally, provide detailed emergence patterns that are not available from larval studies.

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The Humpless Casemaker

By Clarke Garry

Many Kinnickinnic River visitors are familiar with the small (~10 mm), dark, tube-shaped cases commonly seen attached to rocks on the river bottom. Although these cases may be vacated, they are an unmistakable indication of high quality water in our river. These tube cases are fabricated by a caddisfly known as the humpless casemaker, *Brachycentrus occidentalis* (Trichoptera: Brachycentridae), an extremely common benthic (stream bottom) organism in our watershed.

This insect is one of the twenty species of caddisflies I've collected as larvae from the Kinnickinnic River. I presently estimate this species as the second most common caddisfly in the system. Of caddisfly larvae collected to date, 23% (491 specimens) are *B. occidentalis*; the more common netspinner, *Ceratopsyche slossonae*, composes ~33% of total caddisfly larvae. The humpless casemaker has been collected as larvae at all 17 collection sites established along the length of the Kinni from Kinnickinnic River State Park to sites north of I-94.

The common name of this caddisfly comes from the fact that larvae of this species lack both the dorsal and lateral spacers (humps) on the first abdominal segment. (These adaptations play a role in water flow into and out of the cases of most caddisflies.) The observer will likely notice the dark head and thoracic plates, unusually long middle and hind legs, and green body. Technical identification requires observation of (in addition to the absence of humps): 1) small, widely separated plates on the third thoracic segment, 2) a strong furrow across the first thoracic segment, and 3) the presence of four dark setae (hairs) on the ventral (belly) side of the first abdominal segment. Useful keys for technical species identification are Hilsenhoff (1985) and Flint (1984).

Caddisflies (order Trichoptera) are close relatives of butterflies and moths (order Lepidoptera) and as such spin silk that is used for a variety of purposes. One of the major uses is in formation of the case in which the larva lives, which varies in size and composition in the humpless casemaker. In the first instars (early summer), the cases are assembled from small fragments of vegetation which are attached, using silk secretions, transversely; these cases are square in cross-section. As subsequent instars develop (later summer and fall), case enlargement occurs with a mixture of mineral and silk (Gallepp 1974) and lesser amounts of vegetation; at this time the cases become progressively rounder in profile. As the larva begins transformation to the pupa, larger sand grains are added to the case rims (Gallepp 1974). Silk is also used by larvae to do a tethered drift as well as to make cases and attach them to rocks or plant substrate.

Brachycentrus larvae ingest diatoms, algae, plant detritus, and other insects (Wiggins 1998). They feed both by filtering and by grazing. In the first approach, with the case attached to the substrate, they extend the middle and hind legs to extract food particles from the current. The grazing approach (case unattached) is based on scraping of algae from elements of the substrate.

Hilsenhoff, in his 1985 summary of the Brachycentridae of Wisconsin, records five species of *Brachycentrus* in the state. He notes, "All of them tended to be absent from streams that had been subjected to even small amounts of organic pollution, and probably for that reason they were mostly absent from agricultural counties in the south and east." *B. occidentalis* has an assigned tolerance value of 1 (based on a ten point scale, 0=excellent, 10=very poor) (Hilsenhoff 1987), which supports determinations of high quality water when biotic indexing is carried out. *B. occidentalis* is an inhabitant of cold streams, ". . . mostly in those with a significant flow from springs." (Hilsenhoff 1985).

My survey records indicate that mature *B. occidentalis* larvae disappear entirely from the river in late March (the latest record I have is 20 March) and reappear as small larvae in early June. This suggestion of adult emergence (hatch) agrees well with Hilsenhoff's (1985) emergence record of 13 April to 27 May, given a pupal duration of 31-34 days (Gallepp 1974).

Some additional behavioral aspects of *Brachycentrus* life are of interest. Borger (1980) discusses the availability of cased caddis larvae, including *B. americanus* to trout during daytime drift. This, of course, is in direct contrast to the classic nocturnal behavioral drift phenomenon. Waters (1972) references a report of brook trout feeding on day-drifting *B. americanus* larvae. Gallepp (1974), in laboratory studies of *B. occidentalis*, demonstrated that, as pupation approached, filtering behavior ceased and individuals began moving about. With this movement came increased drift in his laboratory stream. An additional curious symbiotic relationship was discovered by Gallepp in studies of wild-collected *B. occidentalis* pupae from a trout stream in central Wisconsin. Thirty-two percent of these pupae were infested with a larva of the chironomid midge, *Eukiefferiella*. It appears that if the midge larva is small, it does no harm to the caddisfly. If it is larger, however, it may kill the host by crowding the case or changing the flow of water necessary for respiration.

Borger (1980) relates that trout scrape caddisfly larvae from the river bottom, ingesting case and all. Certainly the pupae, as they escape their cases and swim to the surface to emerge from the pupal skin, are highly vulnerable to predation. And as in all caddisflies, when females return to the water to lay eggs, yet another life stage of the caddisfly is subject to the attention of feeding trout.

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The Winter Stonefly

by Clarke Garry

I found myself standing in the lower Kinnickinnic River on 1 January 2001 as a partially ceremonial kickoff to another year of macroinvertebrate sampling. After a few kick net samples, I was reminded of a familiar mid-winter benthic collection, a winter stonefly, and the rather remarkable story of its emergence.

For entomologists and flyfishers alike the term "winter stonefly" implies any of a number of plecopterans of the four families Capniidae (slender winter stoneflies), Leuctridae (rolledwinged stoneflies), Nemouridae (nemourid broadbacks), and Taeniopterygidae (taeniopterygid broadbacks). So far, macroinvertebrate and biotic indexing collections have revealed small numbers of two species of nemourids in the Kinnickinnic system, and all of these in expected spring-proximal habitats (mainstem upstream from 140th Street and Kelly Creek). Far more common are members of the family Taeniopterygidae, particularly *Taeniopteryx nivalis*, the early brown or early black stonefly. To date no other winter stoneflies, notably capniids or leuctrids, have been found in the Kinnickinnic watershed.

These stoneflies are univoltine, *i.e.*, having a single generation per year. Adults emerge in late winter and early spring; they mate and the females deposit their eggs in the water. Hilsenhoff (1995) fills in the details of the life cycle: "Larvae hatch from eggs almost immediately, feed briefly, and then burrow into the substrate where they spend the late spring and summer in diapause [a state of suspended growth and development typical of many insects, CG]. Mummy-like diapausing larvae resume a normal appearance in September and commence feeding . . ." Ongoing inventory work suggests that the earliest the larvae appear in the Kinnickinnic is late November, and regular collecting from that point on indicates growth toward maturity through the winter months. (The latest I have collected the larvae from the Kinni is the 20th of March.) Then a real treat is in store on just the right days [those with a combined optimal temperature and day length (Hynes 1976)] in February and March, when the small, dark adults emerge onto the surface of the snow! I know of no observer, including most aquatic entomologists, whose excitement is hidden when talking about these little winter emergers.

Taeniopteryx sp. larvae can be confirmed by locating a single finger-like gill at the base of each leg. *T. nivalis* is distinguished from other taeniopterygid species in its larval form (Fullington and Stewart 1980) by the presence of prominent light yellow margins on the sides of the pronotum and light rings around the eyes. Both of these color features show up well against the dark brown to black body coloration. The antennae, which are as long as the body, are dark brown at the base and transition to a tan-yellow; the two cerci ("tails") show a similar color pattern. The species is described in the literature as both possessing and lacking a light colored, mid-dorsal longitudinal stripe; those of the Kinni mostly lack this stripe. The larvae feed on detritus and diatoms. They are most commonly found in debris and submerged vegetation outside of the strongest current of the river. Stoneflies in general have low tolerance for organic pollution; *Taeniopteryx* species have a tolerance value of 2 (0=excellent, 10=very poor) (Hilsenhoff 1987) and therefore indicate high quality water. I've found *T. nivalis* in almost all of my standard collection locations; they occur from near the delta to north of I-94.

In years with an early spring, emergences of the early brown/black stonefly often end prior to the opening of trout season. In cooler years the hatches are delayed and can occur in-season (Borger 1980). We occasionally wonder on what trout prey in late winter and early spring. This winter stonefly is available in significant numbers during hatches of this period.

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The Giant Stonefly

By Clarke Garry

As part of a display for UW Day in Madison in early March, I had two binocular microscopes set up. I invited passers-by to look at a selection of Kinnickinnic River insects under the 'scope and see a sample of the diversity of life found in the river ecosystem.

I sometimes fail to anticipate that a large insect can hold more immediate attraction and appeal than one which is smaller and less noticeable. It is interesting that once "hooked" on a larger insect many people will become interested in the smaller ones. They can then be fairly easily encouraged to use the microscope to satisfy their curiosity. So while getting warmed up at being in the booth, I quickly learned to pull out the vial with the largest, most intriguing looking insect from the "Insects of the Kinnickinnic" vial rack, the larva of the giant stonefly. I would produce this impressive insect and entice them with something like, "Have you ever seen one of these?"

The giant stonefly of the East and Midwest can be either *Pteronarcys dorsata* or *P. pictetii* (Plecoptera: Pteronarcyidae); the two species look very much alike both as larvae and adults. These are close relatives of the well-known salmonfly (*Pteronarcys californica*) of the West. Placement of all of these, as larvae, into the family Pteronarcyidae can be established on the presence of highly branched gills on abdominal segments 1 and 2 as well as on the thoracic segments. And, of course, the large size of mature larvae and adults (35-50 mm, up to 2") is a real giveaway.

A key provided by Harden and Mickel (1952) allows a reasonable separation of species based on larval characteristics, given that the larva is male. (Separation of female larvae to species is problematic because it is based solely on body length.) In males the triangular shape of the 9th abdominal sternite is diagnostic. All male larva that I have examined to date from the Kinnickinnic have been *Pteronarcys pictetii*.

Numbers of giant stoneflies in the Kinnickinnic are not large. Out of 788 stoneflies that I collected in the 1999 macroinvertebrate inventory, I recorded 31 *Pteronarcys* specimens. Giant stoneflies have an assigned tolerance value of 0 (based on a ten point scale, 0=excellent, 10=very poor) (Hilsenhoff 1987) and so are indicators of high quality water. They occur in the Kinni from Kinnickinnic River State Park to upstream from the Liberty Road bridge. It is interesting (and may be of significance) that I have not found them at sites upstream from this point. This, again, fits a distribution pattern that I've observed in certain mayflies and caddisflies.

Giant stoneflies have a rather ominous appearance with their dark exoskeleton, sharply-cornered pronotum, angular wing pads, stout legs, and robust, cylindrical form. The niche they occupy in the stream, however, is that of shredder. Stewart and Stark (1993) mention that *Pteronarcys* larvae are the "major shredders of CPOM [Course Particulate Organic Matter (particles larger than 1 mm in size)] in stream systems." They also note that, ". . . gut-content studies have indicated that detritus and diatoms are the major *Pteronarcys* food sources . . ."

Giant stonefly larvae develop in moderate current on rocky stream bottoms where their food sources collect. Larvae molt many times as they grow to maturity; this requires two to four years. Mature larvae crawl out of the water onto the bank, typically clinging to a rock or log, in preparation for adult emergence. Adults are sometimes seen in early morning after emergence, or in the evening when they return to the stream to oviposit, but they are basically nocturnal (Borger 1980). Minnesota records indicate that adults of *P. pictetii* emerge in May and June (with one August record) (Harden and Mickel 1952).

Hafele and Roederer (1995) indicate that, "Wherever Giant Stoneflies are found they provide a constant food supply for fish." Borger (1980), speaking of the larvae of these stoneflies, says that trout are ". . . well acquainted with them."

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The Little Yellows

By Clarke Garry

There are normally several logistical considerations associated with making subsurface insect collections in the Kinnickinnic River in January, not the least significant of which is removing the creatures from the sorting tray before the motionless water progresses through the slush stage on its way to becoming ice. Once the assemblage is acquired, however, the collector will be rewarded with an interesting diversity of macroinvertebrates, providing evidence of winter insect activity and the promise of coming spring and summer hatches.

Midwinter Kinni collections collectively yield four categories of stonefly larvae (nymphs), each distinguishable by size and color. These are: winter (= little brown) stoneflies (8-12 mm excluding antennae and tails, dark brown to black), giant stoneflies (35-50 mm, dark grayish brown), common stoneflies (15-25 mm, brown with tan markings), and little yellow stoneflies (10-14 mm, yellow to tan, with darker tan to brown markings on the head and thorax, and a striped or spotted abdomen).

The little yellow stoneflies that inhabit the Kinnickinnic River are members of the genus *Isoperla* (order Plecoptera: family Perlodidae). Hilsenhoff (1995) lists 12 species of *Isoperla* from rivers across the state of Wisconsin; four of these have been found to date in the Kinni. These are: *I. slossonae*, *I. transmarina*, *I. bilineata*, and *I. dicala*. Of these, *I. slossonae* and *I. transmarina* larvae are collected most often and in highest numbers throughout the lower Kinni region. *I. bilineata* is known as a larger river inhabitant and is collected only in small numbers in the downstream regions of the lower Kinni. *I. dicala* is rare.

Stoneflies in general are a sign of high quality water and this is no less true for the little yellows. Biotic indexing tolerance values assigned to these four local residents are: (based on a ten point scale, 0 = excellent, 10 = very poor) 0 for *I. transmarina*, 2 for *I. slossonae* and *I. dicala*, and 4 for *I. bilineata* (Hilsenhoff 1987). With the exception of an occasional isolated specimen upstream, the uppermost occurrences of little yellow nymphs appear to be the Quarry Road-Liberty Road areas. This distribution pattern is similar to one that I've observed and reported for several mayflies, caddisflies, and other stoneflies.

At the time these larvae are observed in January, they're only a few months away from hatching. This adult emergence will occur between mid-April and late June. Hilsenhoff and Billmyer (1973) report a sequence of hatches for Wisconsin as follows: *I. slossonae* emerging mid-April through May, *I. bilineata* and *transmarina* mid-May to mid-June, and *I. dicala* late May to the end of June. These species have a one-year life cycle, spending the summer months as eggs, which hatch in late summer or early fall (Hilsenhoff and Billmyer 1973). Collections from the Kinni are consistent with this generalization, as I have not found any of these species as larvae in the river between 9 June and 9 September.

Although most species of *Isoperla* are carnivorous as larvae (Hilsenhoff 1995), earlier studies referred to by Stewart and Stark (1993) suggest that *I. bilineata* is an herbivore. The little yellows themselves become objects of prey and available to fish as they make their way to the shoreline prior to emergence. Hafele and Roederer (1995) make this comment on adult little yellows: "Look for the females on warm summer evenings when they frequently form large swarms over riffles and runs to lay their eggs. As they gently glide to the water's surface, trout wait below, eager to intercept them."

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The Rusty Crayfish

By Clarke Garry

I still recall my excitement as a young boy (and collector of all things wild) the fun of tying a piece of chicken liver onto the end of a string and fishing for "crawdads" in a local lake near my home in Missouri. Little did I know that 50 years later I would still be collecting crayfish (albeit very different species, in a different way, and for a different purpose). Over the past few years students and I have collected several dozen crayfish from the Kinnickinnic Watershed while working on class projects. And I've picked up additional specimens in the course of the 1999 pilot macroinvertebrate inventory and more recently in the first year of a comprehensive two-year survey.

Most of the crayfish that we've collected from the Kinnickinnic River mainstem and the South Fork appear to be the expected *Orconectes virilis*, the most common crayfish in the state of Wisconsin and the northern-most distributed crayfish in North America (Hobbs and Jass 1988). This species has been collected from several locations in the lower Kinni, from the reach just above the confluence of the Rocky Branch tributary below River Falls to a site within Kinnickinnic River State Park.

So the story is more-or-less predictable to this point. Then, last summer, when I had the opportunity to have Dr. Ray Bouchard of the Philadelphia Academy of Sciences look at a series of unidentified crayfish specimens from the Kinni, the last species I expected him to find was the rusty crayfish, *Orconectes rusticus*. Where finding a giant stonefly or the mayfly *Isonychia* in the Kinni (both less than common occurrences) would be considered promising events, finding the rusty crayfish is just the opposite. Gunderson (2001) refers to the species as a "nasty invader" and Hobbs and Jass (1988) summarize the rusty crayfish in Wisconsin as an ". . . exotic, aggressive, tolerant species that has been extremely successful in the variety of habitats into which it has been introduced."

The rusty crayfish is native to the Ohio River Basin and the states of Ohio, Kentucky, Tennessee, Indiana, and southern Illinois (Gunderson 2001). The range of *O. rusticus* in Wisconsin is disjunct, *i.e.*, not connected to the region of native distribution (Hobbs and Jass 1988). These same authors indicate a modern range of *O. rusticus* across a large part of Wisconsin, except the Trempeleau-Black drainage basin, and they show no historical or literature-based data points for the Kinnickinnic Watershed. The prevailing hypotheses regarding movement of this species from native to non-native regions implicate human conveyance. These include bait transport by non-resident anglers, release of crayfish obtained from out-of-state biological supply houses for use in educational settings, and attempted development of populations of crayfish for commercial harvest (Gunderson 2001).

It has been appreciated for some time that the rusty crayfish has had detrimental effects on Wisconsin lakes, especially northern ones. Demonstrated impacts include: 1) displacement of native crayfish, 2) destruction of aquatic plant beds, and 3) heavy feeding by juveniles on benthic invertebrates (mayflies, stoneflies, midges, sideswimmers) (Gunderson 2001). In an intriguing study by Houghton and others (1998), the Prairie River in north-central Wisconsin was used to test the effect of the presence of *O. rusticus* on the density and diversity of aquatic invertebrates in a coldwater stream. The sections of the river chosen for analysis had three levels of rusty crayfish abundance: upper = not colonized, middle = intermediate colonization, and lower = high abundance. Interestingly, the upper section is classified as a high-grade trout fishery (Class I). The lower section is considered a medium-grade trout fishery (Class II) as the river widens downstream, receives less groundwater influence, and is subjected to increased solar radiation. Following analysis of crayfish and macroinvertebrate populations, as well as multiple environmental factors, it was concluded that ". . . the decrease in benthic invertebrate density was brought about by the increasing abundance of rusty crayfish." An additional conclusion from this study, and one of pertinence to the Kinni, was that colder water temperatures were keeping rusty crayfish from the upper reaches of the studied river. Previous studies referred to by Houghton and others (1998) ". . . found that post-molting mortality in rusty crayfish increased dramatically when the temperature was held below 20°C (68°F), and rusty crayfish did not grow at temperatures below 14°C (57.2°F)."

Johnson's (1995, Fig. 2) record of 1993 summer temperatures (7/18/93 - 8/25/93) for the Kinnickinnic River at Quarry Road indicates an average water temperature of 14.4°C (57.9°F) for this period. And it appears that on only two days during that time did maximum water temperature rise above 20°C (68°F). Additional temperature data (Johnson 1995, Fig. 7) shows Lower Glen Park temperatures running approximately 4°F above example sites at Quarry Road and Cedar Street. Summer data (1 June-31 August) presented for the Quarry Road location in Schreiber (1998) for 1993 through 1997 indicates means ranging from 14.70°C (58.5°F) (1993) to 15.83°C (60.5°F) (1995). Data for the comparable period at the Below Rocky Branch location indicates means ranging from 16.51°C (61.7°F) (1997) to 17.88°C (64.2°F) (1995). To date, specimens of the rusty crayfish have been found in the Kinni only in the area of River Falls, between the Lower Dam and the confluence of the Rocky Branch. It appears at this point that this region may be the most hospitable part of the river for *O. rusticus*. On a larger scale, considering the entire watershed, for most of the calendar year and a significant part of summer, the habitat should be thermally unfavorable for this species.

Rusty crayfish feed on a variety of aquatic plants, benthic invertebrates, detritus, fish eggs, and small fish (Gunderson 2001). Crayfish in general serve as food for trout and other gamefish. Borger (1980) discusses fish preferences regarding crayfish and appropriate fly patterns. Gunderson (2001) reports that rusty crayfish drive native crayfish out of daytime hiding places. Also, as natives swim away from fish attack, they become vulnerable to fish predation, while rusty crayfish aggressively posture, making them less susceptible.

The presence of this introduced crayfish in the Kinnickinnic Watershed is an unfortunate outcome of human intrusion. At present, the species appears to be confined to the reaches just below River Falls. The two impoundments in the City of River Falls have been shown to increase water temperatures for some distance downstream (Johnson 1995, Schreiber 1998), and this situation may be creating an environment which is just suitable for survival of the rusty crayfish. An effort should be made to document and monitor the prevalence of this species in these areas and throughout the system. And here is but another reason to work to maintain and improve on temperature regimes of the Kinni.

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The Common Burrowers

By Clarke Garry

When talking insects with anglers and conservation groups, the Hex is a species about which there are almost always questions. Many people have observed or heard about the impressive hatches of these adults that occur along lakes and large rivers. And its ups and downs through recent time are a "wonderful mystery" (Humphrey *pers. comm.*) that we can now begin to appreciate.

When I initiated my benthic macroinvertebrate work in the mid-'90s, I eagerly anticipated collecting the larval stage of this insect, known as the common burrower. Now-retired colleagues who had taken classes to the Upper Kinni in the early '70s recalled finding mature larvae nearing two inches in length. What a find that would be! When recent sampling produced only a few small larvae in expected locations, including targeted backwaters thick with silt, my questions began. And now I'm understanding that an insect in decline can be an indication of improving water quality.

Plentiful and consistent Hex hatches on the Kinni are referred to as far back as the mid-1940's by Humphrey (1989). Humphrey and Shogren (2001) write of the decline of the Hex and detail possible reasons: "The disappearance of the *Hexagenia* may be the result of improved water quality - falling water temperatures, a reduction in siltation, a speeding of the flow . . ., or other factors beyond our ken." Interestingly, Edmunds and others (1976) build a case for the inflated hatches once seen, ". . . it is almost certain that the great masses of mayflies . . . are a symptom of man's unknowing influence with the environment. Modern man has enriched streams and lakes with sewage from cities, manure and fertilizers from farms, and natural nutrients from eroding soils." Today we see the Kinni responding to earlier stream protection projects, such as fenced easements, which restrict cattle access and encourage bankside vegetation. This protection has lead to a reduction of the impacts expressed by Edmunds, including the important result of lowered water temperature and a shift in the insect community (Engel *pers. comm.*).

The best known of the burrowing mayflies is *Hexagenia limbata* (Ephemeroptera: Ephemeridae). Its reputation is based both on large size (larva and adult up to 32 mm without tails) as well as large hatches. Larvae inhabit silt-based substrates and prefer slower, backwater areas. These larvae are extremely efficient diggers that produce U-shaped tunnels in soft bottom sediments. As with many animals that live in aquatic burrows, the larvae propel water by rhythmically waving their gills (Edmunds *et al.* 1976). From this flow they can filter detritus as well as extract oxygen. Pre-adult subimagoes (duns) emerge from late June into August.

There are four species of the genus *Hexagenia* in Wisconsin. All have an assigned tolerance value of 6 (based on a ten point scale, 0=excellent, 10=very poor) (Hilsenhoff 1987), *i.e.*, a hypothetical biotic index sample composed entirely of *Hexagenia* would rate water quality as fair. This is in striking contrast to today's common Kinni mayflies such as *Ephemerella inermis*, *Baetis tricaudatus*, and *Stenonema vicarium* which have tolerance values of 1, 2, and 2, respectively, and all of which indicate excellent water quality.

[I acknowledge and appreciate informative discussion and correspondence on this topic with Marty Engel, Roger Fairbanks, and Jim Humphrey.]

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Addendum:

One of the purposes of my benthic sampling and databasing project is to develop a permanent record of the macroinvertebrates that are living now in the Kinnickinnic River. I am also interested in documenting entomological changes where possible. I am asking interested anglers to send me any accounts of past hatches, particularly where dates and locations are included, that I can archive as part of my macroinvertebrate records. These will hopefully include, but are not limited to, the Hex hatches.

I would like to receive written Kinnickinnic River and tributary accounts by email (clarke.garry@uwrf.edu) or letter (Department of Biology, UWRF, 410 South 3rd Street, River Falls, WI 54022) and would appreciate an accompanying statement granting me permission to use your account online or in written reports (in which I would acknowledge the contributor). Details regarding this request can be found at:

www.uwrf.edu/~cg04/Kinni_page2000/hatch_accts.html.

Dr. Clarke Garry of River Falls, WI is a ***(now former)*** *professor of biology at the University of Wisconsin- River Falls*