"INFORMANTS ABOUT THE STATE OF OUR STREAMS AND LAKES."

To the layperson, some scientific studies that might be construed to be narrow in focus in fact reveal more than we would expect. Our plenary speakers for the International Mayfly/Stonefly Joint Meeting hosted by the Station August 22-29, 2004 recapped their plenary presentations for our readers focusing on why studying these small creatures matters.

Mayflies in a Changing World

By Professor John E. Brittain

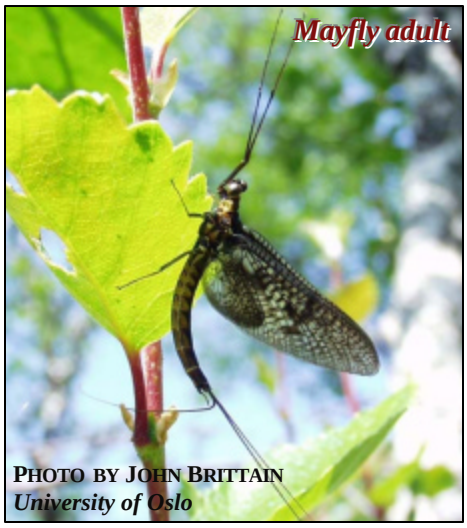

PHOTO BY JOHN BRITTAIN
University of Oslo

At the recent Mayfly/Stonefly meeting held at the Biological Station, I chose to speak about mayflies "in a changing world" as I felt that apart from the intrinsic scientific interest that any group of plants or animals generates, mayflies can tell us an awful lot about the world we live in and how it is changing. They are in a sense our "informants about the state of our streams and lakes."

I started looking into the fascinating world of mayflies in the late 1960s as a doctoral student at the University of Wales. Soon after I moved to Norway, which has been my base ever since, apart from brief stays in Canada and Australia. Norway is a mountainous country and I have developed a particular interest in the rivers and lakes of alpine and Arctic regions.

Although we have many pristine areas in Norway, there are major impacts from acid rain and from hydropower as well as localized affects of urbanization, industries and mining. This has provided the opportunity to develop the use of mayflies and other aquatic insects as indicators of environmental quality.

I am sure we all know mayflies, especially those of us who are fly fishermen. Imitations of mayflies are frequently used to lure fish into thinking they are in for a tasty morsel!

Like all aquatic insects, mayflies grow up in streams and lakes, emerging onto land or into the air as winged adults. Mayflies are unique among insects in having two winged adult stages, popularly known by anglers as the dun and the spinner. In relation to the aquatic stage, which lasts from a few months to several years, the adults are extremely short-lived, only a matter of hours in some species and usually not more than a couple of days. This is the background for their Latin name, Ephemeroptera, which literally means short-lived winged insects.

Despite their seemingly fragile and delicate nature, mayflies are an ancient order of insects that have been around for a very long time, first appearing in fossil records from the Upper Carboniferous Age about 260 million years ago. This means they have survived many major environmental shifts and they have successfully colonized a wide range of freshwater habitats from the tropics to the Arctic.

International Mayfly-Stonefly Joint Meeting Participants at FLBS

While many species of Ephemeroptera display considerable flexibility in life cycle length and timing in relation to environmental changes, others require specific environmental cues. This makes mayflies excellent indicators of climate change.

This was demonstrated a number of years ago in a trout stream in England. A group of fly fishermen had traditionally booked a particular week during spring for fishing just at the time during which there was a major mayfly emergence or "hatch". However, they found out due to global warming, spring was coming earlier, so they were too late for their favorite fishing. Thus, mayflies are giving us an early warning of a warmer climate.

Mayflies are not only good indicators of global warming, but can tell us a lot about the quality of streams and lakes. The species composition and their abundance can tell us if the waters are polluted. For example, many mayflies are extremely sensitive to acidification, even more so than most fish. Thus, again, they can give us an early warning of the effects of acid rain. Here in the Flathead, mayflies and other aquatic insects have provided clear information concerning the impacts of hydropower dams on the ecology of downstream reaches.

At roughly the same time of the year, huge swarms of adult mayflies emerge from certain large rivers and lakes. This can be something akin to a snowstorm when millions of mayflies emerge at the same time. On account of increasing pollution, many of these populations have become

more or less extinct.

However, these massive swarms have returned to several of the Great Lakes as water quality has improved, illustrating the resilience of many of the mayfly species. As I said earlier, mayflies have been around for quite a while and I reckon there is a good chance these fascinating and useful insects will be here with us for some time yet! i

Scale, Hierarchy and Perspectives in the Ecology of Plecoptera (Stoneflies)

By Professor Emeritus Andrew Sheldon

Globally, the few thousand species making up the orders of mayflies and stoneflies are overwhelmed by the diversity of other groups such as beetles and true flies. Yet studies emphasizing scale and perspective reveal their importance to ecosystems.

My conference presentation emphasized scale and perspective; i.e, these orders take on more significance when we focus on freshwater habitats especially in streams and rivers, the most pervasive of continental ecosystems.

The stonefly examples illustrate the importance of scales of space and time in ecology and evolution. At global and "deep time" scales, the stonefly families of the northern and southern hemispheres are almost entirely different recording the travels and subsequent evolution of these ancient insects on drifting continents.

Over short times (seconds to days) in streams pools or riffles, a single trout can intimidate (or eat) predatory stoneflies causing them to occupy different microhabitats or to be less active and visible to trout. The inhibitory effects of fish on stoneflies may cascade down the food chain to insect prey of stoneflies and even to the algal layer on stones if stoneflies regulate grazing insects.

Most of what we know about predatory stoneflies concerns short times and small spatial scales. Scaling up and long-term systemwide effects has been difficult. Recent studies in large experimental streams or with stable isotopes of carbon and nitrogen

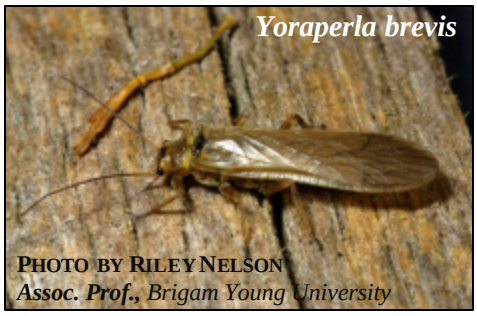

PHOTO BY RILEY NELSON
Assoc. Prof., Brigam Young University

in natural streams across an entire region imply complex and variable roles for predaceous stoneflies.

Stoneflies and other aquatic insects process tons of leaves falling into streams every year. Here our understanding emphasizes ecosystem aspects of matter and energy budgets, but we know very little about such things as drift and settling behaviors by which stoneflies find appropriate leaves to consume. Here the mechanics at short times and small distances are missing as are effects of diversity and quantity of leaf input on the population dynamics of species of shredding stoneflies.

Scale matters in many ways. *Yoraperla brevis (see photo)*, abundant throughout the northern Rockies, is genetically different in each of five nearby canyons in Montana's Bitterroot Mountains implying populations are fairly independent with minimal dispersal of winged adults among canyons. Thus, land managers cannot rely too much on rapid recolonization and "rescue" of badly damaged watersheds.

Here we gained a lot by scaling up from one stream to several, but we remain ignorant of large scale evolutionary diversity of *Y. brevis* across its entire range. Biodiversity conservation of streams and their inhabitants would benefit from this kind of information for single species and at least a sample of ~125 other stonefly species inhabiting Montana.

For stoneflies and other subjects of ecological research, we must consider scale. There are plenty of cases where detailed small-scale research of short duration can tell us what we need to know; however, many of the real challenges and unknowns are at larger and longer scales of space and time. Stoneflies, with their deep history and global distribution, probably know this too. i

Professor Emeritus Andrew (Andy) Sheldon earned his Ph.D. degree in 1966 from Cornell University, ultimately becoming a faculty member at The University of Montana's Division of Biological Sciences. Andy also taught classes at the Station for over a decade and has a well-deserved reputation as an accomplished, dedicated and demanding teacher.

One important legacy is his many students who are now university faculty, aquatic biologists, fisheries managers and ecological consultants. Andy's research and work is described in over 40 scientific publications and covers an impressive array of disciplines including aquatic ecology, fisheries biology, invertebrate biology, conservation biology, community ecology, biogeography, quantitative analysis and limnology. Professor Sheldon's high personal and scientific standards, work ethic, gentle nature and intellect have earned him great respect and affection. He was bestowed with the recognition of Professor Emeritus upon his retirement from The University of Montana in 2003. i

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