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## 28    Towards a standard methodology for the description of mayflies (Ephemeroptera)

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*Many terms and methods in common use in the description of mayflies are defined in an attempt to standardize them. This paper is intended to serve as a base from which mayfly workers can be sure that the same thing is meant by each person.*

### **Introduction**

Many of the terms in common use in the description of mayflies can be somewhat ambiguous in actual practice. I have found these terms can be, and often are, interpreted differently by different workers, sometimes even from the same laboratory, often without these workers being aware that their interpretations differ. This paper is an attempt to standardize some common terms and methods and is intended to serve as a base from which mayfly workers can be sure that the same thing is meant by all. The objective here is neither to stifle individual expression nor to institute an arbitrary and picayune standard to eliminate variations in terminology and techniques, which make no practical difference, but to ensure that points of fact are understood similarly by all.

The terms discussed here were chosen because I have seen these particular ones used in ways that I consider confusing or incorrect. Many of these terms and methods have been, at best, ill-defined in the mayfly literature. I am sure there are many more of which I am unaware.

I have no illusions that everyone will agree with all of my definitions and standards, but these suggestions should serve as a basis for definition from which deviation and rational disagreement can be accomplished. Although the terminology used here is English or Latin, the terms should be directly translatable to other languages in the context of mayfly biology.

Whenever there is any doubt whatsoever as to the meaning of any term, I strongly urge each of you to define exactly what you mean by the use of that term.

## Terminology

**Adult** — I propose that the term *adult* be used to refer to either the subimaginal or the imaginal stage, or both, when neither is specifically chosen (in contrast to the nymphal stage). *Imago* or *subimago* should be used in referring specifically to that stage.

**Basal, apical** — the term *basal* refers to that portion of a structure closest to the attachment to the body. The term *apical* refers to that portion farthest from the attachment to the body, regardless of orientation.

**Body length** [see also total length] — the *body length* is the distance from the anterior-most point of the head or mouthparts (including tusks, etc., if present), not including the antennae, to the posterior-most point of the abdomen, but not including the forceps, penes, egg guide or caudal filaments.

**Caudal filaments** — the three posterior filaments arising from the X<sup>th</sup> abdominal segment of both nymphs and adults are called *caudal filaments*. These *caudal filaments* comprise the two lateral *cerci* (singular *cercus*) and the median *terminal filament* (which is sometimes vestigial or lacking).

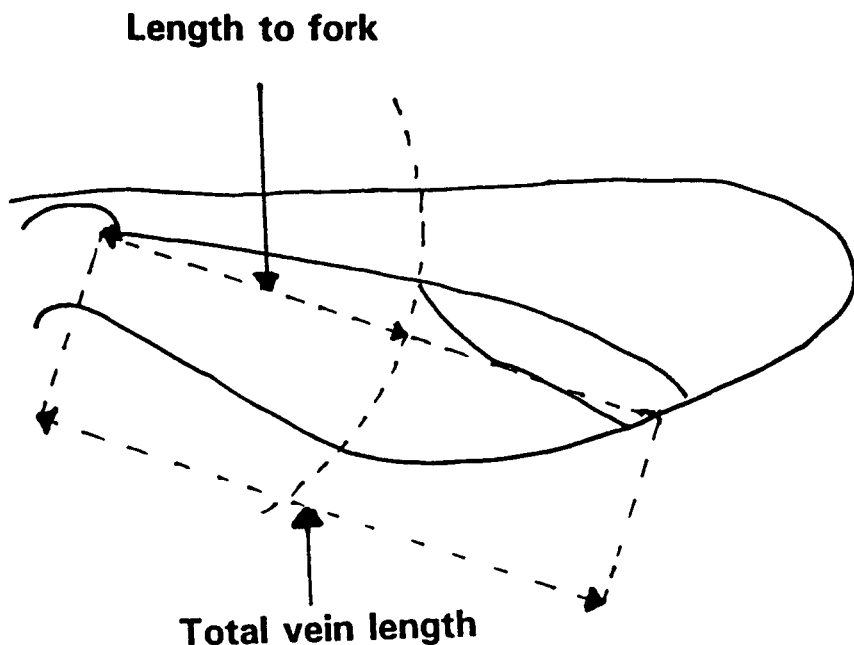
**Egg guide** — the term *egg guide* should be used instead of *ovipositor* (analogous to usage in the Orthoptera [Torre-Bueno 1950, 1989; Brinck 1957]) in referring to the extension of the abdominal sternum used in oviposition by certain female mayflies. An ovipositor refers to a specialized derived structure for depositing eggs, not merely an extension of the sternum as in the Ephemeroptera.

**Ephemeroptera** — the order name *Ephemeroptera*, apparently first used by Hyatt and Arms in 1891, is the name most commonly used by modern mayfly workers (Hubbard 1990). Because the International Rules of Zoological Nomenclature do not apply to order-group names, the names *Ephemerida* and *Plectoptera* have equal validity. I recommend that these names not be used because of their unfamiliarity to many non-mayfly specialists and the likely confusion of the latter with the ordinal name *Plecoptera*.

**Exuviae** — the cuticular parts or cast skin of nymphs or subimagos discarded at ecdysis are referred to as *exuviae*. This term does not exist in the singular: the terms *exuvia* or *exuvium*, which are sometimes seen, have no grammatical standing and should not be used (Snodgrass 1935; Tillyard 1926; Torre-Bueno 1950, 1989; Oxford English Dictionary 1971).

**Fork of vein** — because wing veins often curve or have asymmetric bifurcations, an expression of the distance of the fork from the base of the vein often leads to confusion in interpretation among workers. The point at which a wing vein forks should be expressed as the ratio of the length of the vein between the vein base and the fork to the total vein length. The length of the vein between the vein base and

Figure 1. Measurement of distance of fork from wing base.



the fork should be taken as the distance to the point at which an arc (with its centre at the base of the vein) passing through the fork intersects a straight line from the base of the vein to the *midpoint* of the bifurcation at the wing margin. The total vein length should be measured along a straight line from the base of the vein to the *midpoint* of the bifurcation at the wing margin (Fig. 1).

Gill lamellae — many species of Ephemeroptera have abdominal gills with two lamellae; one dorsal and one ventral. In those species of mayflies that fold the lamellae back along the body, the ventral gill is held closer to the abdomen and the dorsal gill is held on the outside.

Imago [see also adult] — the plural of *imago* is *imagos* or *imagines* (Torre-Bueno 1950; Oxford English Dictionary 1971). Although either term is correct, the use of *imagos* is much more common in the mayfly literature. Of course, the plural of *subimago* is analogous.

Instar — the term *instar* (as well as *stadium*) in common use in the Ephemeroptera refers to the time period between successive ecdyses. It can also (and more correctly) refer to the time period between successive apolyses, although,

because this use is not as common, such use should be clearly stated (see discussion in Fink 1983).

Larva, nymph, naiad — although the term *nymph* is most commonly used by present-day mayfly workers when referring to any of the immature stadia (except for the subimago), *larva* and *naiad* are not unknown, and it introduces no confusion if one of these terms is preferred instead. The historical/traditional views of the distinction among these terms probably has little actual basis. In addition, some workers have used the terms *larva* and *nymph* (and sometimes *pupa*) to refer to selected growth stages of the immature mayflies (e.g., Cianciara 1980). In a rare usage such as this, confusion is quite likely to occur. In such cases, definitions of the terms should be given each time.

Leg orientation — a serious problem arises when we attempt to describe the various faces of the legs. Because different species may present different orientations of the legs, a comprehensive terminology becomes troublesome. For instance, the *dorsal* and *ventral* surfaces of legs extended laterally from the body would become *lateral* surfaces (and *vice versa*) when the legs are extended anteriorly. As a matter of fact, it is possible that the same surfaces of different legs on the same individual would have to be referred to by different terms depending on how each was oriented.

To overcome this problem I propose that leg faces be referenced to as if they were always held in the primitive condition; i.e., extended laterally from the body with the extensor edge oriented dorsally, the flexor edge held ventrally and the adjoining surfaces facing anteriorly and posteriorly (Fig. 2).

This would prevent the problem of *dorsal*, *ventral*, *anterior* or *posterior* changing depending upon the orientation that a particular individual held a specific limb and would facilitate communication in referring to particular portions of the leg.

Leg segment length — the length of a leg segment is measured on the anterior face (see discussion of leg orientation) along a straight line between the *midpoints* of the proximal and distal ends of that segment (Fig. 3). This method reduces variation introduced by curved leg segments or by the frequent property of the flexor and extensor edges being different lengths because of non-perpendicular joints between leg segments.

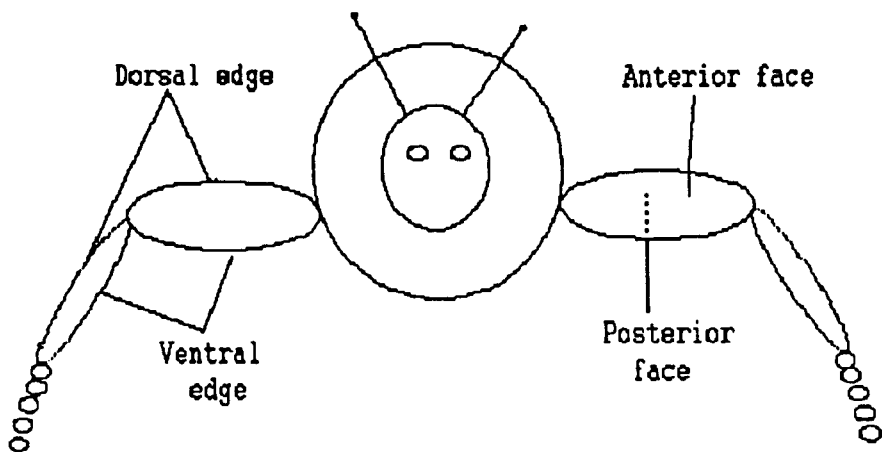
Leg segment ratios — the ratios of leg segments are expressed as ratios of each segment to the tibia length (e.g., femur: unity (actual length of tibia in parenthesis): tarsus 1: tarsus 2: tarsus 3: tarsus 4: tarsus 5).

Mature nymph — a nymph, with black or extremely dark wing pads containing the compacted adult wings, which is almost ready to molt to the subimaginal stage (but is not necessarily the final instar) is often referred to by the somewhat arbitrary term, *mature nymph*.

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**Figure 2.**      **Leg orientation.**

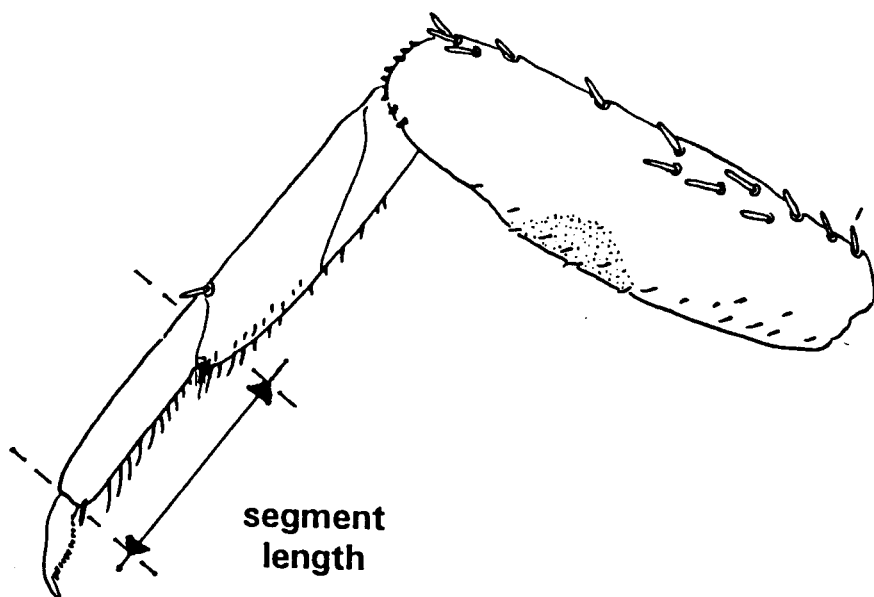
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**Figure 3.**      **Leg segment length.**

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**Palpal length** — the length of a palpal segment is measured on the ventral face along a straight line between the *midpoints* of the proximal and distal ends of that segment, obviating the problem (similar to that observed in measuring leg segments) caused by the common presence of non-perpendicular joints between segments.

**Penes** — the penes (plural) of Ephemeroptera consist of a left and a right penis lobe (singular) (Brinck 1957).

**Proximal, distal** — the term proximal refers to that portion of a structure closest to the body. The term distal refers to that portion farther from the body.

**Ratios** — ratios of measurements, which are expressed in decimals, suggest measurements that are exact to the nearest significant digit whereas the use of fractions suggests an approximation. For example: if one said "segment I is 0.33 times the length of segment II", it would mean that segment I is greater than or equal to 0.325 and less than 0.335 times the length of segment II. If ratios are not exact to the nearest significant digit, then fractions should be used instead; e.g., one would say "segment I is 1/3 the length of segment II."

**Segments** — to reduce confusion, segments (abdominal, palpal, *etc.*) should be referred to by Roman, not Arabic, numerals (i.e., abdominal segment VIII). Arabic numerals should be reserved to represent measurements and counts.

**Subimago** [see also adult and imago] — the terms *subadult* and *preadult* are sometimes used for *subimago* but should be avoided as they serve no useful purpose; the use of *subimago* is well established in the Ephemeroptera.

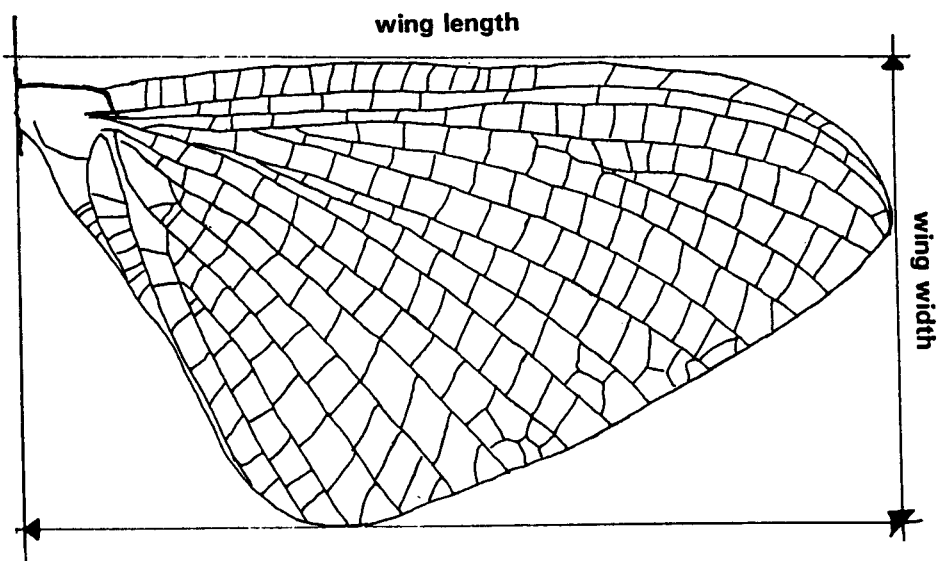
**Tergum, tergite** (sternum, sternite) — the *tergum* is the upper or dorsal surface of any segment of the abdomen, whether it consists of one or more than one sclerite; a *tergite* is a dorsal sclerite or part of a segment, especially when such part consists of a single sclerite (Torre-Bueno 1950, 1989). Because the abdominal terga of mayflies each consist of a single sclerite, one may refer to either the abdominal tergum or to the abdominal tergite of any segment. *Dorsum* refers to the dorsal surface without regard to individual segments. The use of *sternum*, *sternite* and *venter* in referring to the ventral surface of the abdomen or thorax is analogous. *Notum* is usually used in referring to the dorsal surface of the thorax.

**Total length** [see also body length] — the *total length* is the distance from the anterior-most point of the head or mouthparts (including tusks, *etc.*, if present), not including the antennae, to the posterior-most point of the abdomen, including the forceps, penes, egg guide and caudal filaments.

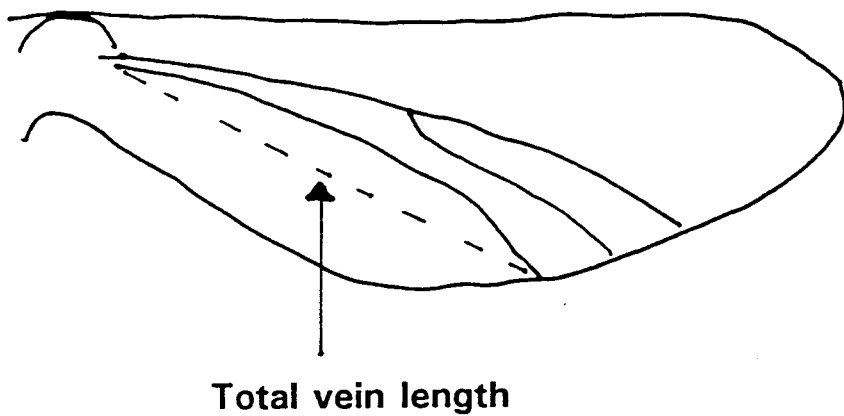
**Wing length** — The *wing length* is measured with the wings spread at right angles to the body and is the distance from the wing fold to the distal-most point of the wing measured perpendicularly to the longitudinal body axis (Fig. 4).

**Wing vein length** [see also fork of vein] — the length of an unbranched wing vein should be measured as a straight line from the base of the vein to the point where the vein reaches the wing margin (Fig. 5). The total vein length of a branched

**Figure 4. Measurement of wing length and width.**



**Figure 5. Measurement of wing vein length.**



vein should be measured along a straight line from the base of the vein to the *midpoint* of the bifurcation at the wing margin (Fig. 1).

Wing width — the *wing width* is measured with the wings spread at right angles to the body and is the distance from the anterior-most point of the wing (including the costal projection if present) to the posterior-most point measured along a line parallel to the longitudinal body axis (Fig. 4).

## Acknowledgements

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