

How to estimate instar

October 22, 2021

Most [odonate larvae \(nymphs\)](#) go through 10-13 stages of development known as “[instars](#).” F-0 is the final instar, F-1 the preceding instar, and so forth.

Sidebar

The “**F**” in the name for every instar stands for Final. “F-0” is the final instar. “F-1” means final instar minus one, that is, the stage that precedes the final instar. “F-2” means two stages before the final instar.

Ken Tennessen, author of [Dragonfly Nymphs of North America: An Identification Guide](#), devised a method for determining instar by examining hind wing length and head width.

Calculating the ratio between hind wing length and head width results in a number that is approximately equivalent to instar, that is, assuming you know how to interpret the result!

The equation for instar equivalent is as follows.

Instar equivalent = HwL / HW

Where **HwL** is **Hind wing Length** and **HW** is **Head Width**.

Math Tips

Fractions are read from top-to-bottom, or when written as shown above, left-to-right. The equation literally says “Instar equivalent equals Hind wing Length divided by Head Width.”

The equation is units independent, meaning any units of measurement can be used as long as the same units are used above and below the dividing line. Instar equivalent is a dimensionless number because the units cancel during division. (Remember “dimensional analysis” from chemistry and physics?)

For most of the life of an odonate larva (nymph) its head is wider than the length of its wing pads. Therefore instar equivalent is calculated by dividing a smaller number by a larger number, resulting in a decimal fraction. As the wing pads grow, the instar equivalent increases until the ratio is approximately 1:1 (or slightly larger) at F-0, the final instar.

According to empirical data collected by Tennessen, average instar equivalents are as follows: ≥ 1.00 for F-0; 0.66 for F-1; 0.50 for F-2; 0.33 for F-3; and 0.25 for F-4. Remember, these numbers are averages — your mileage might vary.

Theory into practice



[Cordulegaster sp. larva](#) (female) | dorsal view

I used the Adobe Photoshop “Ruler Tool” to measure the number of pixels along the two double-tipped white arrows shown in the preceding [annotated image](#) of a preserved specimen.

Tech Tips

[60s 'shop: Using the ruler tool to measure distances in Photoshop CC](#), by Photoshop for the Scientist (1:00) provides a clear and concise explanation of how it's done.

HwL is ~920.81 pixels. HW is ~911.15 pixels.

Instar equivalent = 920.81 pixels / 911.15 pixels

The units cancel, so the answer is ~1.01 — close enough to the average value for F-0 (final instar). Easy, huh?

What are the take-aways?

1. An instar of F-0 indicates the spiketail larva featured in this blog post was nearer the end of the larval phase of its life than the beginning. Time is dilated for larvae in the [Family Cordulegastridae \(Spiketails\)](#), so it's difficult to say how much longer it would have been until the larva [metamorphosed](#) into an adult.
2. Every odonate exuvia is a cast skin of the larva at F-0, the final instar, before it emerges to become an adult. Therefore the instar equivalent for all exuviae should be ≥ 1.00 . Try it and see!

Related Resources

[Dragonfly Nymphs of North America: An Identification Guide](#), by Ken Tennessen. Section 2.5.1 Determining Instar, pp. 27-28.

[A Method for Determining Stadium Number of Late Stage Dragonfly Nymphs \(Odonata: Anisoptera\)](#), by Kenneth Tennessen.

[How to estimate instar, revisited](#)

[How to estimate instar using Photopea](#)

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Tags: [exuvia](#), [Family Cordulegastridae \(Spiketails\)](#), [instar equivalent](#), [Signs of Wildlife](#)

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