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Douglas-Fir Tussock Moth Handbook

Larval Instars of the Douglas-fir Tussock Moth

Larval Instars of the Douglas-fir Tussock Moth

by R.C. Beckwith[1]

In 1974 the U.S. Department of Agriculture initiated the Combined Forest Pest Research and Development Program, an interagency effort that concentrated on the Douglas-fir tussock moth in the West, on the southern pine beetle in the South, and on the gypsy moth in the Northeast. The work reported in this publication was funded in whole or in part by the Program. This manual is one in a series on the Douglas-fir tussock moth.

Douglas-fir tussock moth larvae go through five, six, and occasionally seven developmental stages, or instars, before pupating. Entomologists often need to identify the larval stages in field and laboratory situations. For example, the instars need to be accurately identified for life-table studies in the field. Accurate identification is also important when rearing tussock moth larvae for behavioral studies, virus incidence determination, predator and parasite studies, and bioassay of microbial and chemical spray formulations. Ability to identify instars in the field is also important in planning and carrying out control operations.

This handbook provides a means to identify larval instars of the Douglas-fir tussock moth by visible characteristics. It is not designed to function as a taxonomic description (McDunnough 1921.) All characteristics used for identification—except the head capsule measurements—can be seen with the naked eye or a 10X hand lens. Microscopic examination and measurement of the head capsule will help verify the identification.

The dichotomous key (table 1) separates the first through fifth instars; additional instars are not included in the key because the differences are minor.

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Table 1.—Key to larval instars

I	Thoracic horns and abdominal tufts absent; abdominal glands absent or visible as yellow areas below the surface of the integument on abdominal segments 6 and 7.	First instar
	Thoracic horns and abdominal tufts present, although they may be difficult to see with the naked eye; abdominal glands protrude above the integument on abdominal segments 6 and 7.	See II
II	Thoracic horns short, usually shorter than the length of the head capsule, three dorsal abdominal tufts (located on abdominal segments 1, 2, and 8); dorsal abdominal glands light yellow to yellow.	Second instar
	Thoracic horns longer than the head capsule; more than three dorsal abdominal tufts (located on abdominal segments 1, 2, 3, usually 4, and 8); dorsal abdominal glands orange to red.	See III
III	Abdominal tufts 1 and 2 predominately black.	See IV
	Abdominal tufts 1 and 2 buff, brown, or brown with a darker brown to black fringe.	See V
IV	Auxiliary tuft on abdominal segment 8 absent or very short and erect; abdominal tufts 3 and 4 short and difficult to see, number 4 may be missing.	Third instar
	Auxiliary tuft on abdominal segment 8 present and usually leaning against the anal tuft; abdominal tufts 3 and 4 shorter than 1 and 2, white, and conspicuous.	Fourth instar
V	Auxiliary tuft black; abdominal tufts 1-4 variable in height and color; tufts 1 and 2 larger and fuller than tufts 3 and 4; tufts 3 and 4 white.	Fourth instar
	Auxiliary tuft brown.	See VI
VI	Abdominal tufts variable in height, tufts 3 and 4 shorter and less dense than tufts 1 and 2, tufts 3 and 4 white or rarely brown.	Fourth instar
	Abdominal tufts more uniform in height and quite full; tufts 3 and 4 brown or brown with a dark fringe.	Fifth and sixth instars

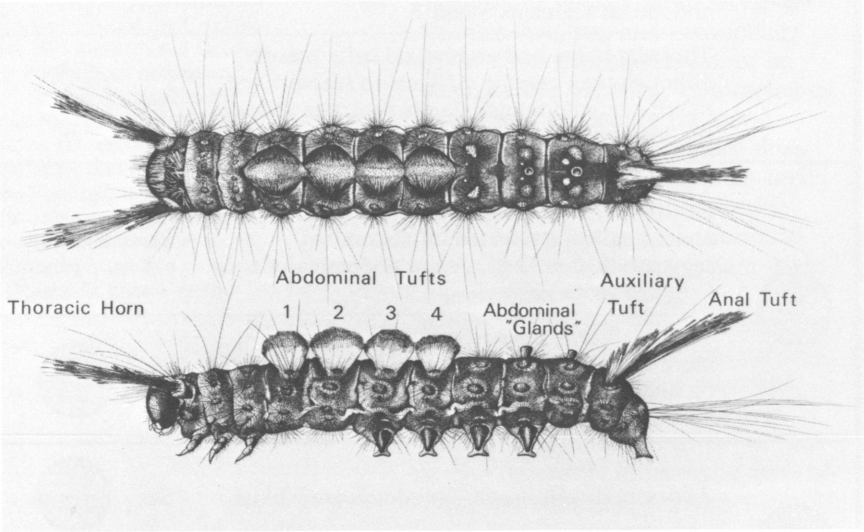

Figure 1.—Mature larva, showing characteristics discussed in text.

The key uses the characteristics and terminology shown in figure 1. Each instar is also described in more detail to aid proper identification. Finally, schematic drawings (fig. 2) and color photographs of each instar provide additional help. The photographs show representative larvae and do not span the variances in size or color patterns. Table 2 lists various tuft color patterns.

The information was developed from and is designed for identifying living larvae. Accurate identifications can also be made of cast skins or dead dried larvae if they are handled carefully. This makes it possible to determine the instar killed by parasites or other factors.

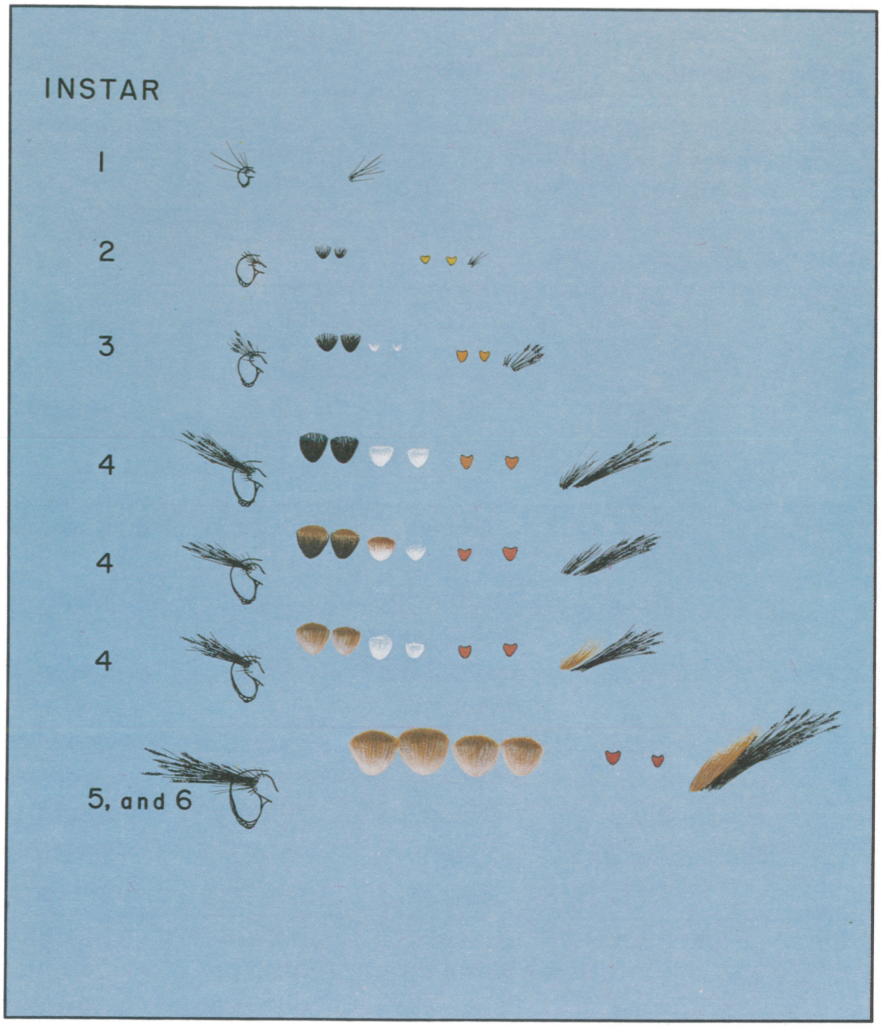

Figure 2.—Tuft color patterns of instars 1 through 6.

Table 2.—Tuft color patterns of Douglas-fir tussock moth larval instars[1/]

Instar	Thoracic horns	Abdominal tufts 1&2	3	4
1st	none	none	none	none
2nd	Short Black	Black	none	none
3rd	Black	Black	Short White	Short White
	Black	Black	Short White	none
	Black	Black	none	none
4th	Black	Black	White	White
	Black	Black with brown tip	White	White
	Black	Brown with black tip	White	White
	Black	Black with brown tip	White with brown tip	White
	Black	Brown	White	White
	Black	Brown	White	White
	Black	Brown	Brown	Brown
5th	Black	Buff with brown tip	Buff with brown tip	Buff with brown tip
	Black	Buff with black tip	Buff with black tip	Buff with black tip
	Black	Brown	Brown	Brown
	Black	Brown	Brown	Brown

[1/] From numerous rearings and various geographical areas during 1973-77.

Glands	Auxiliary tuft	Anal tuft	Remarks
Yellow areas beneath integument	none	none	Larva appears fuzzy because of long hairs especially at ends of the larva.
Yellow	none	Black	Tufts and horns difficult to see without a hand lens.
Orange	Short Black Upright	Black	
Orange	none	Black	
Orange	none	Black	Occasional specimen.
Red/orange-red	Black	Black	Tufts 3, 4 shorter than tufts 1, 2.
Red/orange-red	Black	Black	
Red/orange-red	Black	Black	
Red/orange-red	Black with some brown	Black	Occasional specimen.
Red/orange-red	Black	Black	
Red/orange-red	Brown	Black	Occasional specimen.
Red/orange-red	Brown	Black	Rare specimen.
Red	Brown	Black	Tufts 1-4 rather uniform in height.
Red	Brown	Black	
Red	Brown	Black	
Red	Brown	Brown with black hairs	Rare specimen.

General Characteristics

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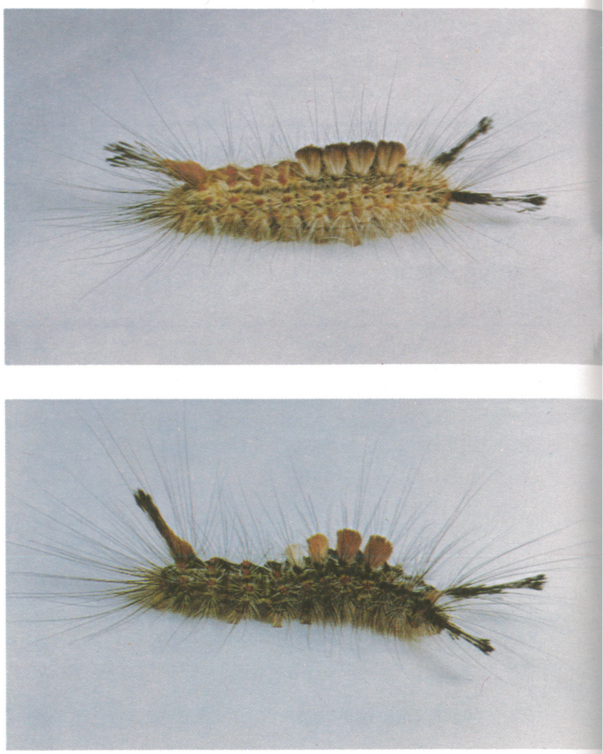

The size and color of Douglas-fir tussock moth larvae depend on a number of factors, including instar, sex, and genetic makeup. The characteristics of the larvae are further influenced by external conditions such as temperature, food supply, and population density. Stress brought on by some unfavorable condition can force development of additional instars that may not look normal. These odd-appearing individuals are not included in the key or descriptions.

The general colors of tussock moth larvae vary from light cream (blondes) to dark gray or black (brunettes), a difference that is especially noticeable in later instars (fig 3). In addition to the lighter body color, blondes also tend to have lighter colored tufts than brunettes. Some larvae appear blonde in the early instars but darken by the last instar.

Figure 3.—Two color variations of Douglas-fir tussock moth larvae: light cream, or "blonde," and dark brown or black, or "brunette".

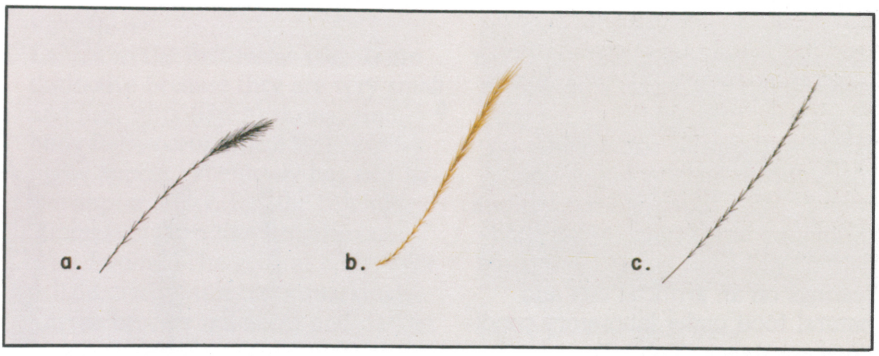

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Figure 4.—Types of larval hairs: "a" and "b" are tuft hairs; "c" is body hair.

The characteristic tufts or tussocks on all instars except the first arise from specific areas (plates) on the larval integument (skin). Tufts are composed of one or two different types of hairs (fig. 4 A and B) which must be present before they are considered to be true tufts. In addition, long body hairs (fig. 4C) may be found in the tuft position, especially in the early instars; these are not tufts unless at least one of the other two hair types is present.

An eversible abdominal gland occurs dorsally on abdominal segments 6 and 7 in all instars except the first (fig. 1). In the first instar, the gland can often be seen through the integument as a yellow circular area. As the larva matures, the gland changes from light yellow to deep red. This color change can be used as a secondary characteristic to help determine the instar.

Head-capsule width can be used to help determine instar. But remember that overlap can occur, especially in the fourth, fifth, and sixth instars. Also, head-capsule size depends on many factors such as population source, larval food, and temperature during the larval stage. Mean head-capsule widths of larvae from many rearings on an artificial diet and natural food under laboratory conditions are shown (Table 3). Remember, a large fourth instar could easily be confused with a small fifth or a large fifth instar with a small sixth if identification were based on head-capsule size alone. Relative head-capsule size and larval lengths are shown for six instars (figs. 5 and 6).

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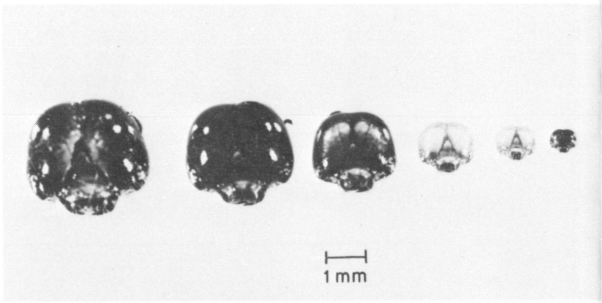

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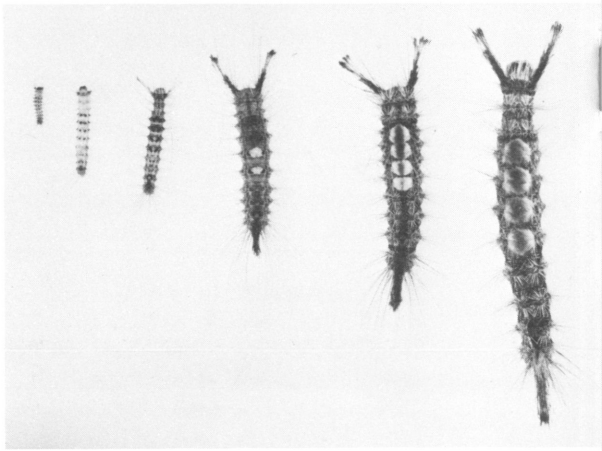

Figure 5.—Relative head capsule sizes of instars 1 through 6.
Figure 6.—Relative body lengths of instars 1 through 6.

Table 3.—Head capsule measurements of laboratory-reared Douglas-fir tussock moth larvae

Instar	Number measured	Mean width (mm)	Standard error
1	358	0.53	0.001
2	350	0.82	0.002
3	336	1.26	0.005
4	314	1.82	0.010
5	115	2.34	0.017
6[1/]	20	3.34	0.143

[1/] Data supplied by Milt Stelzer, Corvallis, Oreg.

Larval Instars

First Instar

Larvae in the first instar (fig. 7) are distinctive because they are very small and lack tufts (fig. 2). Long, fine body hairs occur where tufts eventually appear. The newly hatched larvae appear fuzzy, but the fuzziness diminishes when they lengthen out after feeding. The general body color is light cream with black markings. Larvae become quiescent and darken 1 or 2 days before molting. The abdominal glands have not protruded through the skin but can often be seen as yellow circular spots beneath the skin on abdominal segments 6 and 7. Mean head-capsule width of a large sample was 0.53 mm (range 0.48 – 0.56).

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Figure 7.—First instar larva.

First instars can be difficult to see on foliage, especially when the larvae lie along a twig or on the underside of a needle and do not move. Larvae are usually found in trees by beating a branch over a white drop cloth. The first instar is the primary stage of dispersion between trees. The young larvae spin long silken strands that carry them on wind currents. In dense populations, these silk strands frequently cause "tenting" at the tops of heavily infested trees.

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Figure 8.—Second instar larva.

Second Instar

The beginnings of true tufts are found on larvae in the second instar (fig. 8). The tufts, regardless of their location, have groups of hairs with feathery tips. Thoracic horns arising on either side of the head are short, usually shorter than the head capsule. Abdominal tufts 1 and 2 are present, erect, short, and black; the black anal tuft occurs on the rear part of segment 8. The light-yellow to yellow abdominal glands protrude through the skin on abdominal segments 6 and 7. Mean head-capsule width is 0.82 mm (range 0.72 – 0.92).

The short thoracic horns and the lack of abdominal tufts 3 and 4 are key characteristics used to distinguish second instars. The larvae are difficult to see on foliage unless insect populations are dense. Second instars also spin silken threads, but not as readily as larvae in the first instar. Also, second instars do not usually move from one tree to another on these strands.

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Figure 9.—Third instar larva.

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Figure 10.—Fourth instar larva.

Third Instar

Larvae in the third instar (fig. 9) have tufts that can be seen easily. The thoracic horns are longer than the head capsule. Abdominal tufts 1 and 2 are black and of uniform height. Tuft 3 and sometimes tuft 4 are present; however, they are often short, sparse, and white. A hand lens may be required to see them. The abdominal glands are yellow orange to orange. The auxiliary tuft is sometimes absent; if present, it is very short and erect, rising from the middle of the eighth segment. The mean head-capsule width is 1.26 mm (range 0.92 – 1.34).

Third instars are readily seen in the trees except at low population levels. The larvae will drop on spun threads when disturbed, but not as readily as earlier instars.

Fourth Instar

The prominent, white abdominal tufts 3 and 4, which are shorter than tufts 1 and 2, are characteristic of this instar (fig. 10). Tufts 1 and 2 can be black, black with a brown fringe, brown with a black fringe, or solid brown. The auxiliary tuft is usually black and appears to lean against the anal tuft. Variation in tuft color can sometimes cause confusion with the fifth instar. In those cases, abdominal tufts 1 – 4 and the auxiliary tuft are brown. These larvae can be distinguished as fourth instar by the noticeably short tufts 3 and 4, compared with tufts 1 and 2. The abdominal glands are red-orange to red. Mean head-capsule width is 1.82 mm (1.40 – 1.92); head capsules of larger larvae may be wider than those of small fifth instars.

Larvae in the fourth instar will occasionally spin a silken thread when disturbed, but only rarely. Usually they just fall from the branch.

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Figure 11.—Fifth instar larva.

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Figure 12.—Sixth instar larva.

Fifth Instar

In the fifth instar (fig. 11) abdominal tufts 1 – 4 are nearly uniform in height and color. Tuft color varies from buff with dark brown tip, and buff with black tip to solid brown. The auxiliary tuft is brown, full, and conspicuous. The anal tuft is usually black but may rarely have several brown hairs scattered through it. The abdominal glands are red to deep red. The mean head-capsule width is 2.34 mm (1.82 – 2.68). The low end of this scale overlaps with the fourth instar and the high end with the sixth instar.

Fifth instars usually do not spin threads when disturbed. In the field, most males and some females pupate after this stage.

Sixth and Seventh Instars

Sixth and seventh instars (fig. 12) are similar to the fifth in tuft pattern and color. Tufts are fuller and body size is larger. General body color becomes quite dark in the brunette strain. The larvae in these instars are usually females; however, male larvae under stress sometimes have a sixth instar. Seventh-instar females are also usually the product of stress. Additional instars are probably more common in larvae reared on artificial diets under laboratory conditions than in nature.

The mean head-capsule width of sixth instar females is 3.34 mm (3.10 – 3.65).

References

McDunnough, J. 1921. New British Columbia tussock moth, *Hemerocampa pseudotsugata.* Can. Ent. 53: 53-56.

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