

KEY TO RECOGNIZING *SPODOPTERA LITURA/LITTORALIS* INTERCEPTED AT U.S. PORTS OF ENTRY

S. C. Passoa, 2014

The following key is designed to help separate middle to late instar *S. litura* and *S. littoralis* from other Old World species of *Spodoptera* included in the revision by Pogue (2002).

Data on mandible morphology was taken from Brown and Dewhurst (1975) (African species), Tanada and Beardsley (1957) (*S. mauritia*), Kergoat et al. (2012: fig. 3) (*S. depravata*, *picta*) and Pogue (2002). The mandible of *S. mauritia* is variable, teeth can be present (Tanada and Beardsley 1957: fig. 3) or absent (Brown and Dewhurst 1975: fig. 7F, Pogue 2002: fig. 469-470). Thus, this species is entered twice in the key. Note that mandibles with teeth can be worn smooth (Kergoat et al. 2012), this possibility should be kept in mind. Some doubtful cases among African species can be resolved by head characters instead of mandibles (Brown and Dewhurst 1975: couplet 1).

Distribution and host plant records were taken from Pogue (2002) and Kergoat et al. (2012). To document color variation in *S. litura*, Cox (1976), Bejakovich and Dugdale (1998), Sugi (1987), Wagner et al. (2011) and Komai et al. (2011) were consulted. Color variation of *S. littoralis* was studied using Porter (1997), Sannino and Espinosa (1999), Beck (1999-2000), Gómez de Aizpúrua (1987, 2002) and Ahola and Silvonen [2008]. The color atlas of *S. litura* and *S. littoralis* done by M. van der Straten (unpublished) based on intercepted larvae in the Netherlands was extremely helpful. Consult the data sheets on *S. litura* and *S. littoralis* for characters to recognize the genus *Spodoptera*.

Several species have poorly known larvae and were not included in the key. Kergoat et al. (2012) gave host data and mandible characters for these species. It is not clear if this information was inferred based on the position of a species on a phylogenetic tree or if actual specimens were examined. We present the host data, but consider it tentative. *Spodoptera apertura* is widespread in the Old World, and been reared from tobacco, but immatures are rarely encountered at least in Africa (Brown and Dewhurst 1975). The larva of *S. pecten* has crescent shaped dorsal markings, a wide host range and occurs in Asia (Pogue 2002). *Spodoptera malagasy* is only known from Madagascar (Pogue 2002); it feeds on Solanaceae (Kergoat et al.

2012). Another species with a restricted distribution is *S. umbraculata*. It feeds on Poaceae (Kergoat et al. 2012) and occurs in New South Wales and Queensland, Australia.

Color identification of larval *Spodoptera* is difficult. Although many couplets could be simplified and pruned to just a few key features, an attempt was made to describe the whole caterpillar of each species instead of just a piece of the body. This is necessary because all the various characters need to be weighed in total to choose the right species and exclude similar species outside *Spodoptera* that may match a feature or two.

Separation of *S. litura* and *S. littoralis*, if all the variation is accounted for, is at best subtle and at worst impossible. Each important character seems to be variable and overlapping. The best couplet is the choice that most accurately describes the specimen in hand. Terms like usually, often or sometimes and rarely are an attempt to quantify the frequency of the exceptions. In doubtful cases, choose host and origin over color. On the positive side, larvae of *Spodoptera* do present a characteristic appearance to be learned with experience, even if it is hard to put the differences in words.

Spodoptera species included in the key have a combination of the following characters: head with adfrontal area outlined in white forming an inverted "Y"; mandible with four scissorial teeth and no retinaculum; SD1 on T2 and T3 connected to the associated tonofibrillary platelet by a minute sclerotized bar; SV group bisetose on A1; lateral spot often present on first abdominal segment; and body setae short, most not much longer than the vertical height of the 8th abdominal spiracle *Spodoptera* sp. (1)

1. Larva with a greatly swollen thorax (small, early instars) or origin unknown..... *Spodoptera* sp.
1'. Larva lacks a greatly swollen thorax, (large, middle to late instars), origin known with certainty..... 2

2. Mesothoracic lateral dark spot usually present near SD1; large lateral spot on A1 absent; dorsum colored with an irregular series of white dots and broken lines; if a series of thin black dashes are present then the mandible has scissorial teeth *S. exigua*
- 2'. Mesothoracic lateral dark spot normally absent; large lateral spot on A1 often present; dorsum with triangular markings, or if a series of thin black dashes are present, then the mandible lacks scissorial teeth..... 3
3. Mandible lacks scissorial teeth resulting in a smooth cutting edge.....
..... *S. exempta, S. triturrata, S. cilium, S. mauritia, S. depravata*
- 3'. Mandible with scissorial teeth resulting in a serrate cutting edge 4
4. Abdominal spiracles projecting and tubular (stalked); abdominal dorsum without markings or with irregular blotches; known only from *Pistia* in Asia or potentially could be recovered from a failed introduction to Florida *S. pecticornis*
- 4'. Abdominal spiracles almost flush with body, flat, not projecting; abdominal dorsum with dorsal markings of triangles or dashes (regular pattern); widespread on many hosts..... 5
5. Larva with a wide middorsal yellow (rarely red?) stripe; black marking on A1 thick, contrasting, and almost forming a complete transverse band from the top of the spiracle across the dorsum to the spiracle on the other side; abdominal dorsum mottled white, sometimes with small triangular or semicircular markings lacking an apical white dot; only on Liliaceae from Asia *S. picta*
- 5'. Larva with or without a wide middorsal stripe; black marking on A1 sometimes forms a transverse band across the dorsum; abdominal dorsum not mottled white; triangular or semicircular markings may have an apical white dot; widespread on many hosts 6

6. Frons light tan and contrasting against the darker head; no dorsal white spots on T2 and T3; middorsal line thick and obvious; dorsal markings usually a series of dashes, if very faintly triangular, then an apical white dot is lacking; primarily on Poaceae and Cyperaceae from Asia and parts of Africarare *S. mauritia* with scissorial teeth
- 6'. Frons not contrasting against the darker head; dorsal white spots on T2 and T3 usually present; middorsal line obvious, faint or absent; dorsal markings triangular, often with an apical white dot; from Europe, Asia or Africa, usually not on grass or related plants 7
7. Ground color a shade of chocolate brown to steel gray to dark olive green; subdorsal area usually strongly contrasting with paler dorsum; middorsal line usually faint or absent; spiracular stripe not interrupted on A1 by a black band or spot; dorsal triangles, if present, are on all abdominal segments, A1 and A8, A7 and A8 or just A8 and in most cases lack an apical white dot; sometimes a white spot is present posterior to the abdominal spiracles, more rarely with a dorsal black dot; from Europe to Africa to the Middle East on a wide range of hosts
.....*S. littoralis*
- 7'. Ground color green to yellow brown to dark blue gray; subdorsal area often not contrasting with paler dorsum; middorsal line often obvious; spiracular stripe often interrupted on A1 by a black band or spot; dorsal triangles, if present, are on all abdominal segments, A1 and A8, A7 and A8 or just A8 and most of them usually have an apical white dot; abdominal spiracles usually with a large black dot dorsally and a white spot posteriorly; from Middle East to Asia on a wide range of hosts*S. litura*

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