

## Reassessment of forewing pattern elements in Tortricidae (Lepidoptera)

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Abstract. Forewing pattern elements of moths in the family Tortricidae are discussed and characterized. An historical review of the terminology is provided. A new system of naming pattern elements is proposed.

Key words. Lepidoptera, Tortricidae, forewing pattern, analysis, terminology.

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### I. INTRODUCTION

Early tortricid workers such as HAWORTH (1811), HERRICH-SCHHÄFFER (1856), and others presented the first terminology for forewing pattern elements in their descriptions of new species. Nearly a century later, SÜFFERT (1929) provided a more eclectic discussion of pattern elements for Lepidoptera in general. In recent decades, the common and repeated use of specific terms in descriptions and illustrations by FALKOVITSH (1966), DANILEVSKY and KUZNETZOV (1968), and others reinforced these terms in Tortricidae. BRADLEY et al. (1973) summarized and commented on all the English terms used to describe forewing pattern elements. DANILEVSKY and KUZNETZOV (1968) and KUZNETZOV (1978) analyzed tortricid pattern elements, primarily Olethreutinae, demonstrating the taxonomic significance of the costal strigulae in that subfamily. For practical purposes they numbered the strigulae from the forewing apex to the base, where the strigulae often become indistinct. KUZNETZOV (1978) named the following forewing elements in Tortricinae: basal fascia, subterminal fascia, outer fascia (comprised of subapical blotch and outer blotch), apical spot, and marginal line situated in the marginal fascia (a component of the ground colour).

In 1978 NIHOOT proposed a model of the development of wing patterns in Lepidoptera, and proposed the following terms for the five major type of pattern elements described by SÜFFERT (1929): ripple patterns, dependent patterns, crossbands (fasciae), eyespots (ocelli), and color fields. BROWN and POWELL (1991) found all but ripple patterns in *Epiblema* (Tortricidae: Olethreutinae), and proposed the term “?interfascia” for the regions between fasciae. BROWN and POWELL also introduced a reverse numbering system for the strigulae: four single strigulae from the base to the median fascia (1, 2, 3, 4), and four pairs from the median fascia to the apex (5, 6, 7, 8, 9, 10). In KUZNETZOV’s (1968) previous interpretation of the costal strigulae. BAIXERAS (2002) identified six intervenal terminal strigulae in a species of *Argyroploce* (Olethreutinae: Olethreutini). In contrast,

BROWN and POWELL (1991) found three in *Epiblema* (Olethreutinae: Eucosmini). Based on the cumulative data, BROWN and POWELL (1991) hypothesized that the ancestral tortricine forewing pattern consisted of six fasciae (i.e., basal, subbasal, median, postmedian, subterminal, terminal). They treated the costal strigulae as a dependent pattern element because of the position of the strigulae at the termination of the fascia. In BAIXERAS' (2002) recent treatment of *Argyroploce*, he followed the scheme proposed by BROWN and POWELL (1991).

In this paper the general concepts of "ground colour" (usually weakly pigmented areas) and "markings" (strongly pigmented, usually dark areas located in ontogenetically determined positions) are accepted. However, the particular elements of either may be expressed by aggregations of pigmented scales to various degrees and in various portions. Thus, both ground colour and markings are highly variable and may not be homologous. The term "colour fields" as used by NIJHOUT (1978) and "patches" as used by BROWN and POWELL (1991) may be applicable to almost any element of the tortricine pattern. Therefore it is necessary to apply two parallel terminologies – one for the theoretical or developmental components and the other for practical use, i.e., taxonomic descriptions.

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## II. MATERIALS AND METHODS

Approximately 700 species were examined, either actual specimens under a dissecting microscope or colour photographs of adults. Where necessary, photographs were magnified. Special attention was given to variable species in which the position and configuration of particular pattern elements were inconsistent. Comparison of closely related species and different sexes of sexually dimorphic species were particularly helpful in interpreting pattern similarity and homology.

## III. RESULTS

Depending on the ground colour of adjacent parts of the wing, the marginal strigulae are usually visible. However, they may be reduced or lost entirely. They are regarded here as more or less differentiated, specialized parts of the ground colour. In the costal area of the wing they are distinct primarily in Olethreutinae, especially an antemedian and five postmedian pairs. The terminal strigulae are ill-defined in the majority of species, and the dorsal strigulae are not developed.

Divisions between strigulae usually are dark coloured; however, they may be either enlarged or absent. Both between strigulae and on the dark areas of the remaining parts of the wing there are dark elements of variable size here referred to as "marginal dots" (costal, dorsal, and terminal). The dots often occur singly as small groups of strongly pigmented scales. In other cases they are either enlarged or pairs of adjacent dots are fused.

There are a large number of dots in generalized taxa, but a large number also may be found in some species of the more advanced tribes. The number of dots often is difficult to interpret because of reductions and variation. Of the material studied, a maximum of 34 costal dots were found in *Loxoterma rivulana* (Olethreutinae: Olethreutini) and *Trymalitis* species (Chlidanotinae: Chlidanotini), consisting of 22 dorsal and 12 terminal dots in the former. In *Aleimma loeflingiana* and *Acleris notana* (Tortricinae: Tortricini) there are 24 or 26 costal dots; in *Pandemis corylana* (Tortricinae: Archipini) there are 25 or 26 costal dots; and in *Bactra furfurana* (Olethreutinae: Bactrini) and *Celypha strigana* (Olethreutinae: Olethreutini) there are 28 costal dots.

The costal dots are connected to the dorsal or terminal dots by variably defined transverse lines, frequently consisting of a series of slender transverse dashes or strigulae. These lines, here referred to as "connecting lines", are more or less convex, with their tops at the axis of symmetry of the wing, extending from the middle of the base to the largest pale strip beneath the wing apex (DANILEVSKY

and KUZNETZOV 1968). The costal parts of the postmedian lines often are strongly oblique (e.g., *Anacylis*, some *Eucosma*).

The field(s) between two or more neighbouring lines may be filled with dark pigment and form the fasciae. Costal parts of the fasciae often are more intensely expressed, frequently forming separate blotches (three in the posterior part of the costa separating the major costal strigulae). Some parts of the ground colour also may be strongly pigmented between the connecting lines. In addition, dark areas of ground colour and markings may coalesce.

Below I re-define the major elements of forewing pattern in Tortricidae, assigning the elements to two categories – primary and secondary. The locations of the features are illustrated in Fig. 1.

#### IV. PRIMARY ELEMENTS OF TORTRICINE PATTERN

**Basal fascia (BF).** Comprised of two or three dots (and lines); often not expressed or reduced to lines or marginal dots.

**Subbasal interfascia (sbi).** Comprised of one line or its marginal dots; often at least partially expressed with colour of markings.

**Subbasal fascia (SBF).** Comprised of two or three lines; often connected with basal fascia to form a basal blotch.

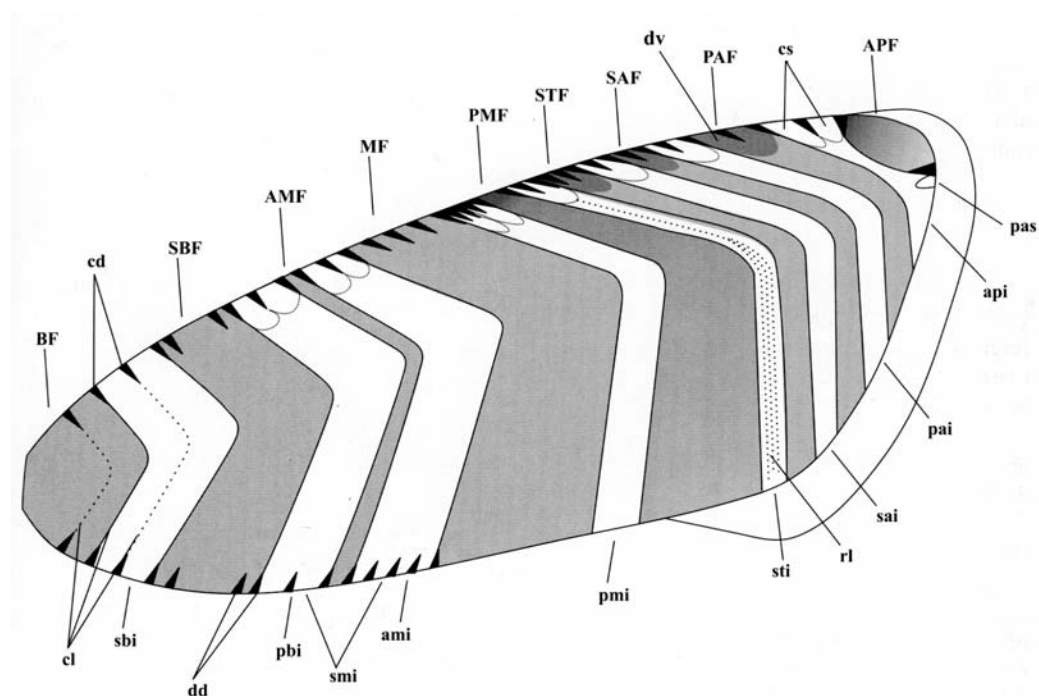


Fig. 1. Diagram of the forewing pattern of Tortricidae. Fasciae: BF – basal fascia, SBF – subbasal fascia, AMF – antemedian fascia, MF – median fascia, PMF – postmedian fascia, STF – subterminal fascia, SAF – subapical fascia, PAF – preapical fascia, APF – apical fascia; interfasciae: sbi – subbasal interfascia, pbi – postbasal interfascia, ami – antemedian interfascia, smi – submedian interfascia, pmi – postmedian interfascia, sti – subterminal interfascia, sai – subapical interfascia, pai – preapical interfascia, api – apical interfascia; cd – costal dots, cl – connecting lines, dd – dorsal strigulae, dv – dividing, pas – postapical strigula, rl – refractive line. Note: marginal dots marked only along costa (cd) and in basal part of dorsum (dd), terminal dots not figured; costal strigulae (cs) of basal part of costa omitted, terminal strigulae except for the postapical strigula (pas) and terminal dots omitted; only one example of refractive line (rf) figured (between PMF and STF).

**Postbasal interfascia** (pbi). Comprised of one line and one pair of distinct costal strigulae. When the antemedian interfascia is not expressed, a broad fascia of ground colour (i.e., submedian interfascia) may be present, often with a differentiated dorsal portion (i.e., dorsal patch).

**Antemedian fascia** (AMF). Comprised of two dots; a slender fascia (unnamed but illustrated by DANILEVSKY & KUZNETSOV 1968) dividing the first pair of major costal strigulae.

**Submedian interfascia** (smi). Comprised of one dot; a slender fascia between subbasal fascia and median fascia.

**Median fascia** (MF); comprised of five dots (= subtornal fascia of DANILEVSKY & KUZNETSOV (1968)).

**Postmedian interfascia** (pmi). Comprised of a slender interfascia beyond the median fascia with four dots, two of which usually are completely reduced or ill-defined in the costal region, dividing two postmedian pairs of major costal strigulae (e.g., Eucosmini). Theoretically these should continue as fasciae, but they atrophy subcostally where they are replaced by the refractive line (see speculum below).

**Postmedian fascia** (PMF). Comprised of two dots at the costa and four at the dorsum (probably one pair at the costa is completely reduced). The dorsal half of this fascia is strongly expanded to form the (speculum) field in the majority of Tortricidae and the ocellus proper in Eucosmini and Grapholitini. Its proximal edge is limited by the anterior line (a continuation of the refractive line), its distal edge by the posterior line (lines of speculum), and within it are some longitudinal marks referred to as inner spots of the speculum. The posterior line is a continuation of the refractive line, extending from the second postmedian pair of the major costal strigulae. It represents the strongly reduced subterminal interfascia.

**Subterminal fascia** (STF). Comprised of four dots on the first large division developed between the median fascia and the apex of wing, occurring between the fourth pair of major costal strigulae. It extends from the costa to the termen, terminating near the tornus.

**Subapical fascia** (SAF). Comprised of three dots at the costa situated in the second of the three broad costal divisions; separated from this latter by the subapical interfascia (sai).

**Preapical fascia** (PAF). Comprised of a single fascia originating at the costa (the third large division between major costal strigulae) and reaching the termen; proximally limited by the preapical interfascia (pai).

**Apical fascia** (APF), apex. Comprised of one costal and one terminal dot; limited by the apical interfascia (api) and wing edges.

**Marginal dots**. Comprised of small groups of well-pigmented scales at the wing edges: the costal dots (cd) along the costa, the dorsal dots (dd) along dorsum, and the terminal dots along termen.

**Connecting lines** (cl). Comprised of slender pigmented markings connecting the marginal dots.

**Costal strigulae**. Comprised of pale marginal elements of ground colour, highly specialized in the majority of Olethreutinae. The dorsal strigulae are indistinct; the terminal strigulae often are more visible, forming pairs divided by marginal (terminal) dots. There usually are four or six pairs of major costal strigulae, one before the median fascia (often there are two rather small antemedian pairs separated by the antemedian fascia).

(Speculum). The medio-tornal area of the postmedian fascia, usually differing in colour from adjacent areas, edged with the anterior and posterior lines (refractive lines), provided with small groups of strongly pigmented scales called inner spots. These are not developed in Tortricinae or Chlidanotinae, but are distinct and numerous in Olethreutinae (e.g., *Eucosma pupillana*).

## V. SECONDARY ELEMENTS OF TORTRICINE PATTERN

The terms listed below are commonly used in the taxonomic literature. They refer to elements composed of markings and ground colour. The examples provided are from RAZOWSKI (2001); the species names are accompanied by the numbers from the colour plates of that work.

In the basal area of the wing may occur the **basal blotch** (e.g., 165 *Pseudeulia asinana*, Tortricinae: Archipini; 211 *Isotrias hybridana*, Chlidanotinae: Polyorthini; 291 *Loxoterma bipunctana*, Tortricinae: Cochylini) formed by the fusion of the basal fascia, subbasal interfascia, and postbasal fascia. The **dorsobasal blotch** (or dorsobasal spot when small) (e.g., 171 *Archips podanus*) consists of all those elements that comprise the dorsal or/and dorso-median parts of the basal area. The **post-basal blotch** (e.g., 367 *Epinotia ramella*, Olethreutinae: Eucosmini) is the dorsal part of subbasal fascia usually coalesced with part of subbasal interfascia (expressed dark between lines).

In the **submedian interfascia**, the most frequently differentiated part is the **dorsal patch** (= interfascial spot of BROWN and POWELL (1991)) (e.g., 231 *Lobesiodes occidentis*, Olethreutinae: Olethreutini; 243 *Aterpia sieversiana*, Olethreutinae: Olethreutini; 244 *Epiblema scutulanum*, Olethreutinae: Eucosmini). It often is subdivided by the antemedian fascia (e.g., 434 *Epiblema scutulanum*, Olethreutinae: Eucosmini) or by two additional lines to form four slender pale markings (e.g., 509 *Grapholita compositella*, Olethreutinae: Grapholitini). Often anterior or posterior parts of the patch are completely darkened, and the pale marking changes its position and is more or less slender (e.g., 591 *Dichrorampha petiverella*, Olethreutinae: Grapholitini).

The **median fascia** often is divided into a **costal spot** and a **dorsal blotch** or fascia, sometimes with the costal part atrophied (e.g., 108 *Aethes badiana*, 49 *Cochylimorpha clavata*, Tortricinae: Cochylini). It may be partially fused with some adjacent markings situated either anteriorly or posteriorly (e.g., 90a *Aethes deutschiana*, 122 *Cochylis dubitana*, 125 *C. posterana*, Tortricinae: Cochylini). Similar to the situation in the dorsal part of the submedian interfascia, the postmedian interfascia may form dark elements which often coalesce with or join adjacent fasciae.

The **subtornal blotch** (subtornal spot, pretornal marking, tornal marking) is comprised of variably expressed elements of the dorsal part of the postmedian interfascia (e.g., 448 *Epiblema similanum*, Olethreutinae: Eucosmini) or postmedian fascia (e.g., 301 *Phiaris palustrana*, Olethreutinae: Olethreutini). Often a large dark marking fused with the dorso-posterior part of the median fascia is considered the median fascia, despite the fact that it is composed of both the postmedian interfascia and the postmedian fascia (e.g., 289 *Loxoterma rivulana*, Olethreutinae: Olethreutini).

The **subapical blotch** (subapical spot, preapical spot) is comprised of three (less frequently two) dark costal divisions between the costal strigulae, i.e., the costal portions of the subterminal, subapical, and preapical fasciae (e.g., 151 *Cnephasia communana*, Tortricinae: Cnephasiini; 161 *Parameisia gnomana*, Tortricinae: Archipini).

The **costal blotch** is a large feature consisting of several pattern elements (e.g., 9b *Acleris laterana*, Tortricinae: Tortricini), including the median fascia, the postmedian fascia, the subterminal fascia, and parts of the interfasciae between them. Compare with "colour fields."

The term **subterminal fascia** often is applied to its posterior or median parts only (the subterminal fascia proper). It often is fused with parts of the following two elements. In Cochylini this term (= postmedian fascia of BRADLEY et al. (1973)) describes a combination of the subtornal blotch, the median portion of postmedian fascia, and the costal part of the preapical fascia (e.g., 104 *Aethes bilbaensis*).

The **terminal fascia** is comprised of separated posterior portions of the subterminal, subapical and preapical fasciae.

The **tornal marking** (BRADLEY et al. 1973) is a part of subtornal blotch or the dorsal portion of the postmedian fascia. Compare with subtornal blotch.

In morphological descriptions the term **spot** is reserved for small pattern elements (e.g., 423 *Eucosma campoliliana*, Olethreutinae: Eucosmini and 493 *Cydia zebeana*, Olethreutinae: Grapholitini). BROWN and POWELL (1991) applied the term to larger elements, e.g., “interfascial spot.” The **discal spot** is a pale mark at the end of the median cell (e.g., 209 *Eulia ministrana*, Tortricinae: Euliini; 222 *Endothenia marginana*, Olethreutinae: Endotheniini).

Small, point like elements of various origin are referred to as **dots** (e.g., 17 *Acleris lorquiniana*, Tortricinae: Tortricini). Compare with marginal dots.

**Strigulae** or strigulation refers to short transverse lines or strips usually between veins (e.g., 14 *Acleris rhombana*, Tortricinae: Tortricini). Compare with costal strigulae.

**Shades** refer to suffusions darker than the ground colour or diffuse areas of markings, such as the remnant of the basal blotch (e.g., 193 *Aphelia viburnana*, Tortricinae: Archipini) or the dark terminal part of the wing (e.g., 209 *Eulia ministrana*, Tortricinae: Euliini).

**Dividings** or divisions are dark costal parts of markings (dv) or larger marginal dots (cd) separating costal strigulae (e.g., 429 *Gypsonoma sociana*, Olethreutinae: Eucosmini).

**Colour fields** is the term coined NIJHOUT (1978) for blotches consisting of at least two elements (e.g., 316 *Ancylis unculana*, Olethreutinae: Enarmoniini; *Epinotia solandriana*, Olethreutinae: Eucosmini). BROWN and POWELL (1991) differentiated colour fields into “patches” and “spots”.

**Radial markings** are longitudinal fasciae extending along the costa, dorsum, some veins, or joining the base and the apex of the wing. They are probably forms of colour fields.

**Patch** is a term used by earlier authors (e.g., BRADLEY et al. 1973) for the dorsal part of the submedian interfascia. BROWN and POWELL (1991) applied it to the dorsal part of the submedian interfascia (“interfascial spot”). Compare with colour fields and dorsal patch.

**Refractive markings** are primarily the lines composed of glossy scales found in interfasciae edging the pattern elements (i.e., lines of speculum). These also are the discontinuous lines retained in the form of spots. They may occur in pigmented parts of the interfasciae attached to dark parts of the pattern or within other defined markings.

## VI. CONCLUSIONS

Forewing pattern elements in the three subfamilies of Tortricidae are homologous. They develop by expression of pigment between transverse lines, here termed the connecting lines, which join dark dots occurring along the costa and dorsum or termen. There are nine distinct fasciae (including the apex), one permanently reduced fascia (between the median and postmedian fasciae), and eight interfasciae. In the majority of species the pattern is obscured by variable expressions (stronger or weaker pigmentation) of adjacent elements.

The pattern in Olethreutinae is more generalized than in Tortricinae and Chlidanotinae, but may be specialized to varying degrees. In some primitive groups of Tortricinae (e.g., Phricanthini; *Aleimma* and *Acleris forsskaleana*, Tortricini) and Chlidanotinae (*Trymalitis*, Chlidanotini) the generalized pattern is retained. Variation among different states of development of pattern may be seen within genera or even among colour forms of particular species.

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