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avives@eresmas.net
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Solovyev, A. V.
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Musculature of the male genitalia of the genus *Taeda* Wallengren, 1863 (Lepidoptera: Limacodidae)

A. V. Solovyev

Abstract

The musculature of the male genitalia of the genus *Taeda* Wallengren, 1863 is examined (based on study of the species *T. gemmans* (Felder, 1874) and *T. aetitis* Wallengren, 1863). The following muscles are reported for *Taeda*: m1 - "uncus depressor"; m2(10) - "muscles of tuba analis"; m4 - "valva adductor"; m5(7) - "intravalvar muscle"; m6(5) - "protractor of aedeagus"; m8(3) - "ventral abductor of valva"; m7(6) - "retractor of aedeagus".
KEY WORDS: Lepidoptera, Limacodidae, *Taeda*, *Pantoctenia*, musculature of male genitalia.

Musculatura de la genitalia del macho del género *Taeda* Wallengren, 1863 (Lepidoptera: Limacodidae)

Resumen

Se examina la musculatura de la genitalia del macho del género *Taeda* Wallengren, 1863 (basada sobre el estudio de las especies *T. gemmans* (Felder, 1874) y *T. aetitis* Wallengren, 1863). Se indican los siguientes músculos para *Taeda*: m1 - "depresor del uncus"; m2(10) - "músculos del tuba analis"; m4 - "adductor de la valva"; m5(7) - "músculo intravalvar"; m6(5) - "protractor del aedeagus"; m8(3) - "abductor ventral de la valva"; m7(6) - "retractor del aedeagus".
PALABRAS CLAVE: Lepidoptera, Limacodidae, *Taeda*, *Pantoctenia*, musculatura de la genitalia del macho.

Introduction

The genus *Taeda* Wallengren, 1863 with type species *Taeda aetitis* Wallengren, 1863 includes middle-size moths known from Afrotropic. The genus is well diagnosed externally and by the genital characters of both sexes (JANSE, 1964), however its relations with *Pantoctenia* Felder, 1874 (type-species: *Pantoctenia gemmans* Felder, 1874) are not clear. Previously both genera were regarded as synonyms by HERING (1928). Later JANSE (1964) considered the genus *Pantoctenia* as a separate one and argued his opinion by the position of the vein R5 in the forewings. It was postulated that the vein R5 is connate with the stalk R3+R4 in *Taeda* and it is remote from the stalk R3+R4 in *Pantoctenia*. JANSE (1964) noted that there are no other strong differences in venations and in male genitalia between both *Taeda* and *Pantoctenia*, and the differences in female genitalia (excepting the signa) and external characters are very weak. Thus, in the present paper the point of view of HERING (1928) is accepted and the genera *Taeda* and *Pantoctenia* are considered as synonyms that is based on external similarity of the type-species (illustrated in JANSE, 1964), their male and female genitalia. The particularities of the forewing venations and signa in female corpus bursae in both genera are considered as not of generic-level.

Nowadays the genus *Taeda* (= *Pantoctenia*) includes the following species: *T. aetitis* Wallengren,

1863, *T. gemmans* (Felder, 1874) (= *Pantoctenia albipuncta* Druce, 1887), *T. prasina* Butler, 1896, *T. connexa* (Janse, 1964), and *T. punctistriga* Weymer, 1908. In addition, the species *Taeda pusilla* Aurivillius, 1899 is also placed in *Taeda* by many entomologists (HERING, 1928; JANSE, 1964), but the external characters of adults including forewing pattern and coloration of this species are quite different from those of *Taeda* (however male genitalia and forewing venation are similar). It is proposed here that the species *pusilla* should be placed into another genus, but that is the aim of another research. Thus, the species composition of *Taeda* is just preliminary and needs further investigations.

The genus *Taeda* (= *Pantoctenia*) along with *Crothaema* Butler, 1880 is characterized by a complex of plesiomorphic characters within Limacodidae (EPSTEIN, 1996) and therefore both genera can be considered as the most primitive among the members of the family Limacodidae. In *Taeda* the medial stem in the hindwing venation is divided, something that is known in just a few other limacodids. In its larvae the crochets on A2-A7 and on A10 appear after the first instar (noted for *Taeda gemmans* (Felder, 1874) (EPSTEIN, 1996) though the crochets are not reported for other limacodids. Many other characters of *Taeda* not listed here appear to be plesiomorphic and resemble that of the related families (Dalceridae and Megalopygidae) (EPSTEIN, 1996).

The goal of the present investigation is examination of the musculature of the male genitalia of *Taeda* in being one of the most primitive genera of the family Limacodidae. The system of the family is not apparent so far and the present study can help with understanding of evolution of the family and with interpretation of the diversity of the musculature of the male genitalia in other genera.

Up to the present, the musculature of the male genitalia were examined in just a few genera of Limacodidae (KUZNETZOV & STEKOLNIKOV, 1981; 2001; STEKOLNIKOV, 2008; SOLOVYEV, 2010; ZOLOTUHIN *et al.*, 2013) and the following groups of muscles were revealed: m1 - “uncus depressor”; m2(10) - “muscle of conus analis”; m4 - “valva adductor”, m5(7) - “intravalvar muscle”, m6(5) - “protractor of aedeagus”; m8(3) - “ventral abductor of valva”; m7(6) - “retractor of aedeagus”; m20 - “internal muscle of tuba analis” (nomenclature sensu STEKOLNIKOV, 2008). Muscles m2(10) and m20 are reported just for a few members of Limacodidae. Most species of Limacodidae are characterized by a tendency of rotation of the aedeagus around its axis; in such cases the muscles m6(5) and m7(6) are asymmetric and moreover the muscles m6(5) are "crossed" in some limacodids (KUZNETZOV & STEKOLNIKOV, 2001; STEKOLNIKOV, 2008; SOLOVYEV, 2010). A priori it can be postulated that the complete set of muscles should be found in *Taeda*.

In addition, muscle m3(2) (“dorsal abductor of valva”) was found in the family Chrysopolomidae (ZOLOTUHIN *et al.*, 2013). The family Chrysopolomidae is regarded as closely related to Limacodidae and sometimes considered as a subfamily within Limacodidae (EPSTEIN, 1996). Thus, the muscle m3(2) is also expected in *Taeda* as in one of the most primitive genus within the Limacodidae.

Material and methods

The 70% alcohol material on the genus *Taeda* used in the present study was kindly given by Prof. Vasily V. Anikin (Saratov State University; Saratov, Russia). The material on *T. gemmans* (Felder, 1874) was collected in Republic of South Africa, Free State, 20 km W of Winburg, Erfenis Dam, 28º 29’ 63” S, 26º 47’ 69” E, 31-XII-2007 and on *T. aetitis* Wallengren, 1863 is in Republic of South Africa, Free State, 20 km S of Harrismith, Sterkfontein Dam N.R., 28º 23’ 59” S, 29º 02’ 38” E, 30-XII-2007.

The standard methods were used in examination of musculature (KUZNETZOV & STEKOLNIKOV, 2001). The drawings were prepared using the following method. First, the abdomen of the moth was macerated in 10 percent water solution of alkali for ten minutes under heating. The genitalia were dissected using micro-forceps. The dissected genitalia were photographed under different angles using stereomicroscope Micromed MC-2 Zoom with digital camera Levenhuk C510 NG; later the pictures were printed and the contours of the genitalia were drawn on the clear sheet of paper by transparency. The minor particularities of the genitalia were drawn by sight. These pictures were scanned

and the scans are the base for the next step. For examination of the musculature of the male genitalia the material kept in 70% alcohol was used. The genitalia were dissected and stained with dyes Evans Blue and eosin for better contrast and visibility of the muscles and sclerites. The muscles were drawn on the previously prepared scans in Corel Draw X5. The images were finally completed in Corel PhotoPaint X5.

Results

The musculature of the male genitalia was examined in *T. gemmans* (Felder, 1874) (Figs. 1-2) and *T. aetitis* Wallengren, 1863 (type-species of *Pantoctenia* and *Taeda* correspondingly). The male genitalia and their musculature are quite similar and there are no important differences excepting some specific characters dealing with different shapes of uncus, gnathos, juxta, valva and aedeagus.

In *T. gemmans* the uncus is a triangle in back view (Figs. 1-2). The gnathos is long, massive, with long unpaired medial part. The subanal plate is not developed. The tegumen is wide. The valvae are elongated, broad, somewhat rectangle. The valva has two types of basal processes; the first process is a triangle and short, running from the costa (it can be considered as "hemitranstilla" sensu KUZNETZOV & STEKOLNIKOV, 2001; STEKOLNIKOV, 2008) and the second one is long, finger-shaped, running subcostally (it can be regarded as "basal process of valva" sensu KUZNETZOV & STEKOLNIKOV, 2001; STEKOLNIKOV, 2008). Indeed, transtilla (or "hemitranstilla" - interrupted medially transtilla) and "basal process of valva" are similar functionally and topologically, however they are usually clearly separated in some Lepidoptera (KUZNETZOV & STEKOLNIKOV, 2001; STEKOLNIKOV, 2008) and such differentiations can be useful for further phylogenetic analysis. Such a particularity of the valvae is also found in *T. aetitis* Wallengren, 1863 and *T. prasina* Butler, 1896 and probably it is typical for *Taeda*. The juxta is flattened, broad, fused ventro-laterally with the sacculus of the valva. The vinculum is slender. The saccus is long, craniad. The aedeagus of *Taeda* is usually strongly curved medially and bears an apical spur in some species. The male genitalia of *T. gemmans* are slightly asymmetric that is caused by the dorso-lateral position of the ejaculatory duct (located on the left side).

The following paired muscles were found in the members of *Taeda* (Figs. 1-2): m1 - "uncus depressor"; m2(10) - "muscle of tuba analis"; m4 - "valva adductor", m5(7) - "intravalvar muscle", m6(5) - "protractor of aedeagus"; m8(3) - "ventral abductor of valva"; m7(6) - "retractor of aedeagus". Muscles m1 are typically for most Lepidoptera running from the anterior margin of the tegumen to the ventral subapical part of the uncus. By contraction of m1 the uncus is depressed. Muscles m2(10) run from the anterior medial part of the tegumen to the lateral parts of the tuba analis; their contraction causes retraction of the tuba analis. Muscles m4 run from lateral parts of vinculum to the finger-shaped basal processes of the valva ("basal processes of valva" sensu KUZNETZOV & STEKOLNIKOV, 2001; STEKOLNIKOV, 2008). Muscles m5(7) are flexors of the valvae; they run from the base of the sacculus to the proximal third part of the inner wall of the valvae. Muscles m6(5) are synergists of muscle m4 and their contraction causes a retraction of the aedeagus as adduction of the valva. These muscles run from the proximal third of the external wall of the valva to the coecum; it was already noted that the aedeagus is somewhat asymmetric and the ejaculatory duct located on the left side of the aedeagus, but the muscles m6(5) are bilateral symmetric. Muscles m8(3) typically for most limacodids run from the saccus to the lateral parts of the juxta; the juxta of *Taeda* fused with the sacculus of the valva ventro-laterally and therefore at contraction of muscle m8(3) the valvae are abducted. Thus, muscles m8(3) are indirect abductors of the valvae and such a mechanism is reported also for other Lepidoptera (KUZNETZOV & STEKOLNIKOV, 2001; STEKOLNIKOV, 2008). Muscles m7(6) are antagonists of m6(5), run from the saccus to the medial part of the aedeagus and are attached to the aedeagus distally to the opening of the ejaculatory duct.

Thus, the set of muscles in *Taeda* is well corresponding to some other Limacodidae. Muscles m20 are not found in *Taeda*, although found in some "advanced" limacodids such as *Iragoides* Hering, 1931, *Chalcocelis* Hampson, 1893, *Chalcoscelides* Hering, 1931 and *Belippa* Walker, 1865. Probably

muscles m20 are reduced independently in different lineages of Limacodidae. Muscles m3(2) ("dorsal abductor of valva") typical for Chrysopolomidae are not developed in *Taeda*; it is highly possible that their absence is diagnostic for all Limacodidae. Most limacodids are characterized by asymmetric male genitalia (members of the genera *Chibaraga* Hering & Hopp, 1927, *Cania* Walker, 1855, *Monema* Walker, 1855, *Parasa* Moore, 1859 s. lat., *Apoda* Haworth, 1809, *Austrapoda* Inoue, 1982, *Ceratonema* Hampson, 1893, etc.) caused by the rotation of the aedeagus around its axis and, correspondingly, by the crossing of the muscles m6(5); such a tendency is also somewhat observed in *Taeda* and this character can be regarded as a basic for the Limacodidae, however other investigations involving other Limacodidae are necessary for exact conclusions.

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A. V. S.
Ulyanovsk State Pedagogical University
Zoology Department
RUS-432700 Ulyanovsk
RUSIA / *RUSSIA*
E-mail: solovyev_alexey@mail.ru

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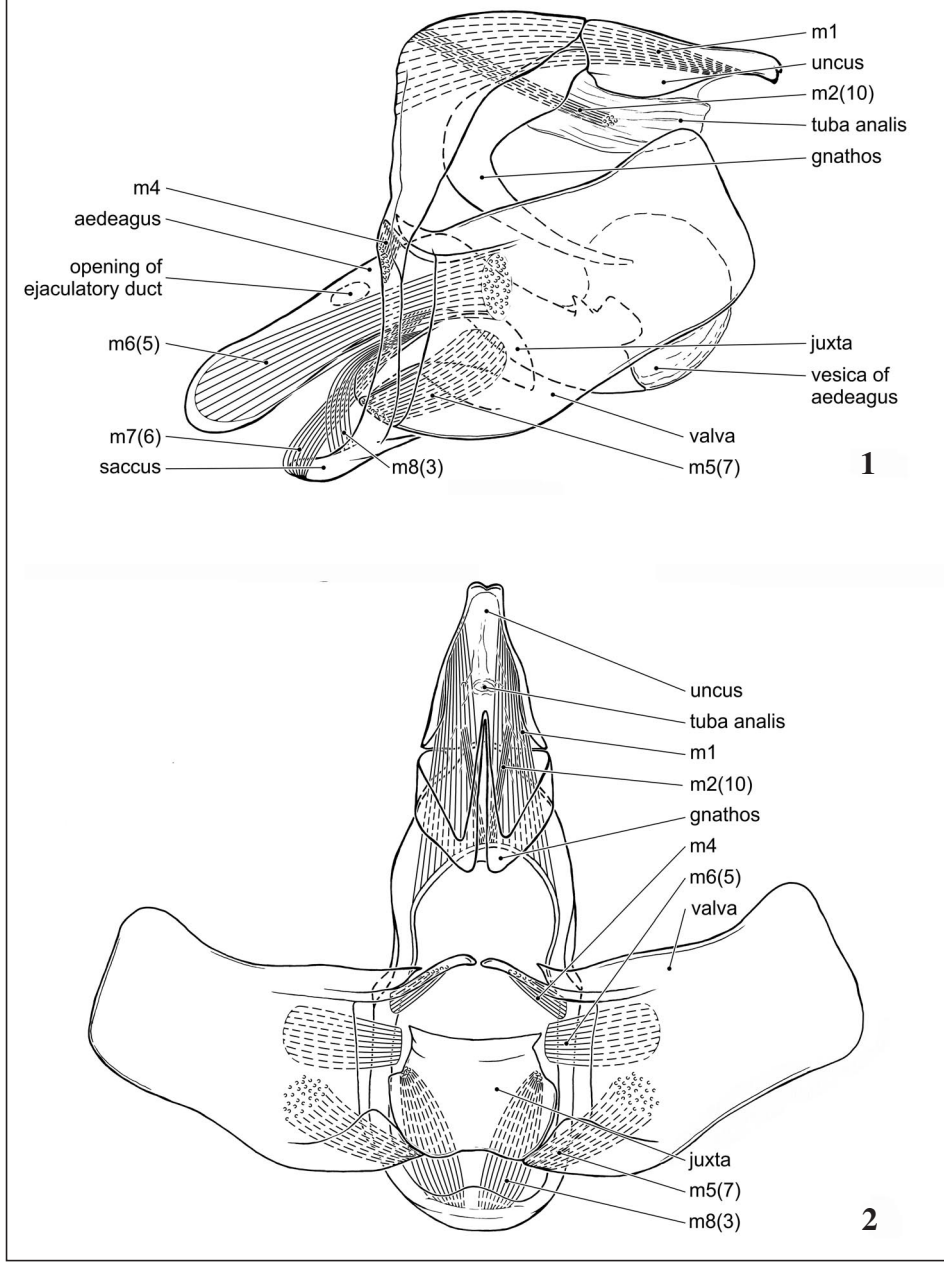

Figs. 1-2.– Scheme of male genitalia of *Taeda gemmans* (Felder, 1874). **1**. lateral view; **2**. back view; the valvae are slightly spread. Abbreviations are given in the text.