SHILAP Revista de lepidopterología, 45 (177) marzo 2017: 37-46 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.970

Morphological analyses of two gynandromorphy individuals of Geometridae (Lepidoptera: Geometridae)

S. Seven & M. Özdemir

Abstract

In this study, gynandromorphs individuals of *Gnopharmia cholcidaria* (Lederer, 1870) and *Idea adeversaria* (Linnaeus, 1758) from Turkey were observed morphologically, compared to each other and normal individuals. *Idea adevarsaria* shows female characteristics in external morphology. Howewer, *Gnopharmia colchidaria* shows both male and female characteristics in phenotype, which has external characters of female on the left and of male on the right side. Though male genitalia is dominant in *G. colchidaria,* characteristics concerning both male and female genitalia are found to be equal in *I. devarsaria.* Morphological structures and their measurements in gynandromorph individuals are given and figured.
KEY WORDS: Lepidoptera, Geometridae, gynandromorphy, Turkey.

Análisis morfológico de dos individuos ginandromorfos de Geometridae (Lepidoptera: Geometridae)

Resumen

En este estudio, fueron observados morfológicamente individuos ginandromorfos de *Gnopharmia cholcidaria* (Lederer, 1870) e *Idea adeversaria* (Linnaeus, 1758) de Turquía, comparándolos con otros individuos normales. *Idea adevarsaria* muestra las características de la hembra en su morfología externa. Sin embargo, *Gnopharmia colchidaria* muestra las características fenotípicas del macho y de la hembra, con las características de la hembra a la izquierda y del macho a la derecha. Aunque la genitalia del macho es dominante en *G. colchidaria*, se observan las características del macho y de la hembra por igual en *I. devarsaria.* Las estructuras morfológicas y medidas de los ginandromorfos, se muestra en el trabajo.
PALABRAS CLAVE: Lepidoptera, Geometridae, ginandromorfo, Turquía.

Introduction

A gynandromorh is an individual in which one part of the body is masculine and the other is feminine. Among insects, bilateral gynandromorphs are most frequent, in wiht the left and right halves are of different sexes (MAYR & ASHLOCK, 1991). However, anteroposterior gynandromorphs and forms with irregular mosaic-like distributions of sexual characters also are known (RICHARDS & DAVIES, 1977). This phenomenon is widespread among animals, mainly invertebrates and less frequently among Vertebrata with a few controversial cases (BENOIT, 1950; ABELLA, 2002). Gynandromorphism is very rare in nature, and for this reason gynandromorph specimens were rarely collected and described. WHITE (1973 *in* O'HARA 1983) estimated frequency is about 0.01 to 0.05 % of natural occurrence of gynandromorphs in an insect population.

Lepidopteran gynandromorphs have been recognized in species with sexual dimorphism where the

male has coloration and/or pattern elements that typically differ from those of the female. Hence, notable sexual differences in phenotype appear on the two halves of the adult (JOSEPHRAJKUMAR *et al*., 1998). The phenomenon of gynandromorphism is well known among the Lepidoptera, but it occurs in various groups with different frequency. Anomalies of embryogenesis during the very initial stages result in various parts of the insects body that are marked with characters of different sex (NEKRUTENKO, 1965). JACHONTOV (1935) explained the origen of gynandromorphism by the abnormal division of nuclear substance in the division of the fertilized egg; if this takes place at the very first division, a bilateral gynandromorphism and arises. If such an anomaly occurs at the later stages of the egg division, the gynandromorph will be a mosaic. MORGAN (1905) submitted the relationship between gynandromorphismand embryogenesis in insects at his study. This phenomenon is mentioned in some papers in Lepidoptera (EMMEL, 1964; FLYNN, 1982; MOTTA, 2000; IVINSKIS & SALDAITIS, 2001; GUZMÁN, 2005; TENNET, 2006; BERNARDINO *et al*., 2007).

Gynandromorph individuals belonging to the Family Geometridae which are in the collection of authors herewere examined anatomically and morphologically, and compared to other normal individuals.

Material and Method

Individuals belonging to two types from Family Geometridae which are in Gazi University Zoology Museum and Agricultural Combat Research Institutes Museum were examined in this study. Samples were extended in accordance with the museum material methods and their genital preparations were set. Abdomens of samples were ruptured by means of a forceps and were boiled in 10% KOH for a while, then processed in water and alcohol series respectively. Then they were placed in creosote and lastly were attached between lam and lamella with Canada balsam. Prepared samples were examined by means of Leica MZ 9.5stero microscope and their photographs were taken. Identifications of the samples were made by comparing them with related literature (SCOBLE & KRÜGER, 2002; HAUSMANN, 2004).

Results and Discussion

Description of gynandromorph specimens

Gnopharmia Staudinger, 1892

Gnopharmia cholcidaria (Lederer, 1870) (Figure 1-6)

Imago (Figure 1): Wingspan is 22 mm. Wing is bilateral symmetric, there is no variation relating to pattern. Base colour of the upper wing is red brown, it bears reddish coloured band on submarginal and distal which lies from front wing to the rear wing. On the exterior side, there are canescent zigzag band on marginal, two black bands on costa and beneath that an underdeveloped spot is observed. Underside of the wing is homogenous and it bears a significant band on corners (Figure 1 B). Wing patterns on both left half and right half are similar. On the left half, spots are more significant. While the antenna on the left side is bipectinated which is intrinsic to the male characteristics, antenna on the right side is flagellate and bears female characteristics (Figure 1A). Thorax and abdomen is symmetric, as well as the wings. Legs have similar characteristics.

Head and head measurements: As for many biological species, males are small in terms of body sizes, yet their chordotonal organs are more developed specially to find the female. In *Gnopharmia cholcidaria,* left eye proportions (respectively width-length) are 0.56/0.97 and right eye proportions (respectively width-length) are 0.49/0.93 (Figure 2).

Wing and wing measurements: Wing connection in Lepidoptera is obtained by means of some special systems called jugum and frenulum. In some groups, these systems vary across male and female individuals (sexual dimorphism). Thus, frenulum on right half of the examined sample is formed from a single hair that is observed in normal male individuals (Figure 3b). However, on the left half it consists of hair bundle

observed in normal female individuals (Figure 3a). Moreover, it is defined that left wing of Gynandromorph individual is relatively smaller than the right wing (Figure 4).

Genitalia (Figure 5): Genitalia structure is asymmetrical, while all systems of male genital is observed on one half of the abdomen, only an apophysis belonging to the female genital is seen on the other half. All male systems are developed well on the left half, apophysis and its extensions belonging to the female genital stands out on right side, attached to uncus. Beneath this system, clasper in parallel with the one on left side system is developed. Aedeagus which serves a function in sperm transfer is developed in normal place and with normal systems. Vinculum and gnathos has normal characteristics. A differentiated characteristic is observed in gynandromorph individual as well as the male individual in 8th and 9th sternite from Ennominae subfamily of Geometridae family; it does not disappear on the right side where the female characteristics develop (this system shows no differentiation in females) yet an abnormal development is observed.

Idaea deversaria (Herrich-Schäffer, 1847)

Imago (Figure 6): Wingspan is 26 mm. Wings has light yellow and light-greyish-yellow colored patterns, patterns are more significant compared to normal individual. Terminal area is darker, lines are wavy. Transversal lines are brownish. Postmedial line is slightly wavy. Discal point is more indefinable compared to normal individuals. Terminal line and fringe points are quietly insignificant. Wing patterns on both left half and right half are similar. Frons is deep brown, vertex is canescent, neck is reddish brown.

Head and head measurements: Distance between antennas and segments are indefinite, cilia are present, partially long and sparse. Dramatic differences are not observed proportionately (Figure 7).

Wing and wing measurements: Measurements of wings are same on both sides (Figure 8). Frenulum-retinaculum system providing connection between front and rear wing consist of multiple hair bundle as for the female individuals. Besides, a hair that is better developed compared to others is present in this bundle (Figure 9).

Hindlegs: Sexual dimorphism is observed in normal individuals from this group. Male individuals bear a hair bundle in meta-tibia. On the other hand, females have thinner hindlegs compared to male individuals and do not bear a hair bundle (Figure 10). It is determined that examined gynandromorphy individuals do not bear hair bundle in meta-tibia and have thinner hindlegs as in the case of females (Figure 11).

Genitalia (Figure 12): Genitalia structure is asymmetrical. In one half of the abdomen, some parts of male genitalia are blunt and deformed and all parts are present, in the other half female genitalia structures stand out. Male structures are better developed on the left but vulva distinguished in apical and with a dens in subapical has curled and partially deformed on left. Structures in vulva apical on right are completely blunt. Uncus and gnathos seem normal with fairly narrow structure. Juxta has a double row spine row. Aedeagus has fairly lengthened and enlarged. There is no cornutus is aedeagus and a dense vesica stands out.

Table 1.– Morphological structures and their measurements in gynandromorph individuals (A: Antenna, BÖ: Head measurements, KÖ: Wings measurements, KB: Wings connections, B: Hindlegs, G: Genital.

Taxon	**Antenna leftright**		**HeadMeasu-rements**		**WingMeasu-rements**		**KB**		**Hindlegs**		**Genital**	
			left	right	left	right					m*	f*
Gnopharmia cholcidaria	bipectinat	filiform	0.56 0.07	0.49 0.03	12.70 9.12	13.23 9.63	Hairbundle	Singehair	No hair bundle	No hair bundle	Wholedeve-loped deformative	No Ductus-bursae
Idaea deversaria	filiform	filiform	0.81 0.46	0.82 0.49	12.60 6.14	12.95 6.12	Hairbundle	Hairbundle	No hair bundle (slightly thicker)	No hair bundle (thinne)	Wholedeve-loped deformative	Wholedeve-loped deformative

Discussion

SCUDDER (1889) cited a report by Dr. Hagen of 31 gynandromorph species, mostly European, in the Papilionidae, Pieridae, Lycaenidae, Nymphalidae and Satyridae in which most showed complete bilateral distinction. He suggested that the left side is usually female and in a few cases one side will have mixes sexual differences. Both EMMEL (1964) and OPLER (1966) figured a *Colias* and *Lycaena*, respectively, in which the female is on the right dorsal surfaces. Bilateral gynandromorph moths have recently been reported by HESSEL (1964), MULLER (1966) BLANCHARD (1969) in which the specimens exhibit female characteristics on the right dorsal surfaces. NIELSEN (1977) reported a gynandromorphic individual belong to Hesperiidae. KUTIS & HEPPNER (1990) mention a rare gynandromorph of Geometridae from Florida showed a perfectly bilateral division between the female with different antennae, the thorax and the posterior anal tufts of the abdomen. DALLA TORRE & FRIESE (1899) classified gynandromorphs according to the topology of mixed female-male characters. They divided gynandromorphism into four groups according to its levels as lateral deviants, transverse deviants, frontal deviants and mixed deviants.

The gynandromorphic specimen of *G. cholcidaria* described, clearly belongs to the lateral deviants, whith a female left side and male character on the other side. In gynandromorphic individual of *G. cholcidaria* at one side we find antenna bipectinate, wings smaller, frenulum with a single hair, while on the other side the antenna filiform, wings are bigger and frenulum has a hair bundle shape. The other gynandromorphic individual of *Idaea deversaria* shows frontal deviants characters. On both sides antenna are filiform, wings measurements are the same, frenulum shows hair bundle shape like in female, hindlegs are without hair and have the same shape (Table 1). Although, characteristics belonging to the male genitalia structure are dominant in *G. colchidaria* characteristics regarding to male and female genitalia is found to be equal in *I. deversaria.*

Consequently, this situation which we encounter in the same family or in two different species, indicates that individuals experience gynandromorphism in different stages of their embryonic developments.

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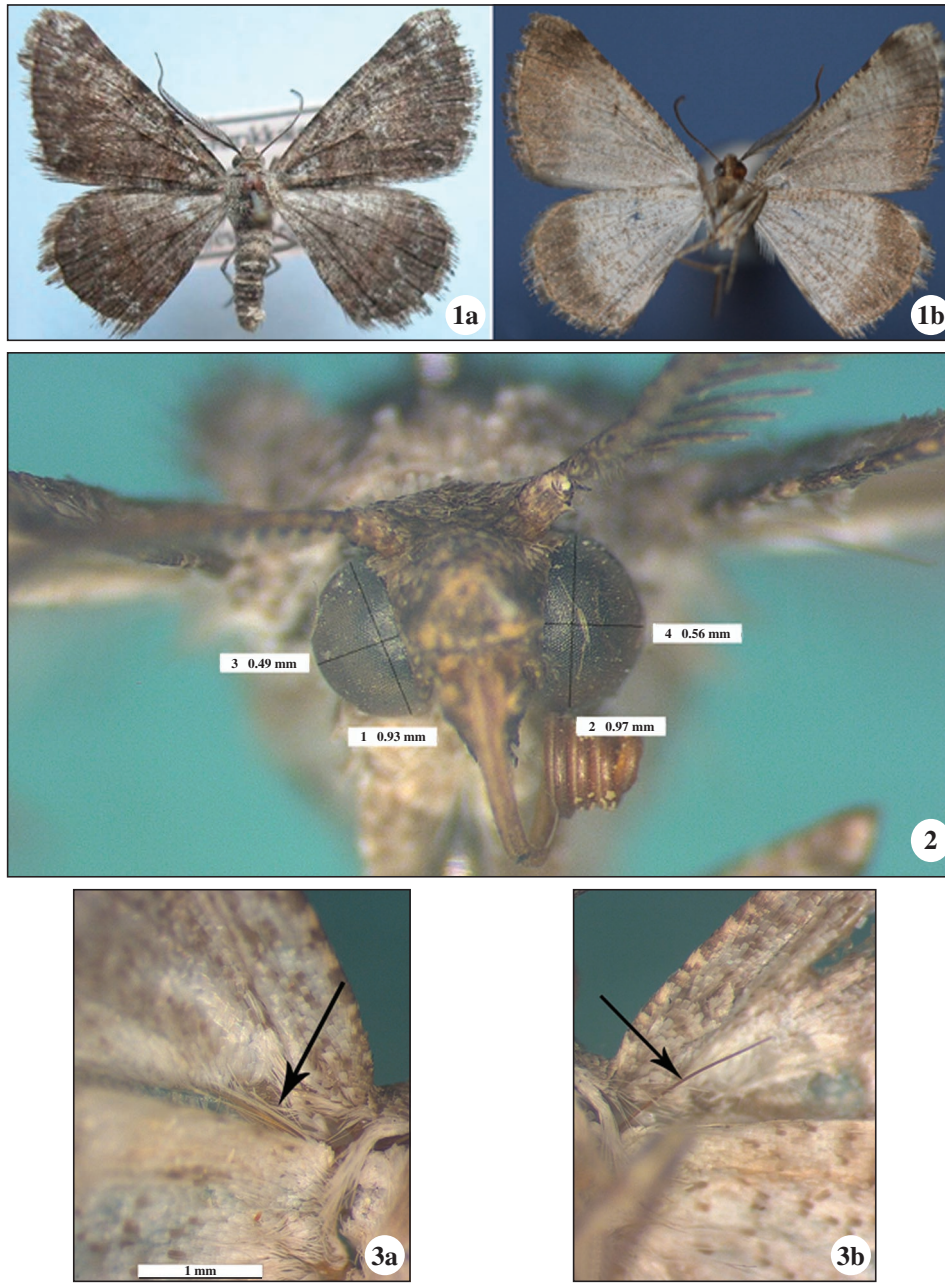
*S. S.
Gazi University
Science Faculty
Biology Department
TR-06500 Ankara
TURQUÍA / *TURKEY*
E-mail: selma@gazi.edu.tr
https://orcid.org/0000-0003-4406-6768

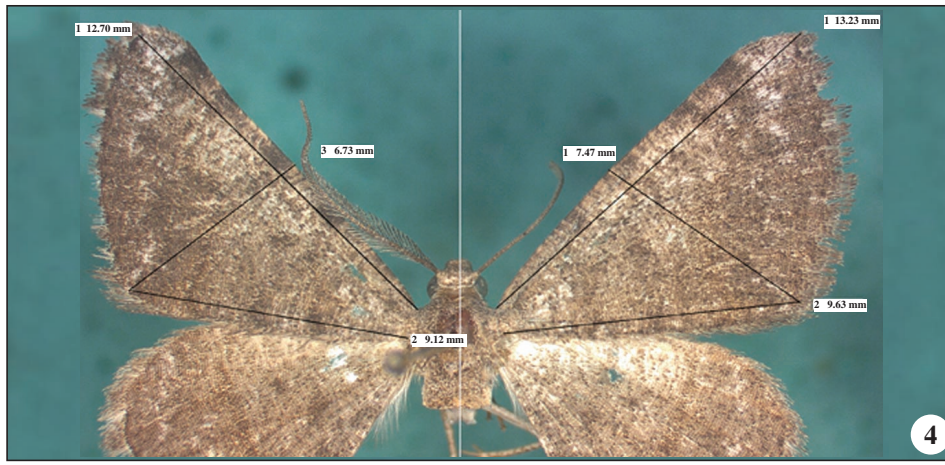
M. Ö.
Ministry of Food Agriculture and Livestoc
General Directorate of Agricultural Research and Policy
Plant Protection Central Research Institute
TR- 06172 Yenimahalle, Ankara
TURQUÍA / *TURKEY*
E-mail: ozdemir_m@lycos.com
https://orcid.org/0000-0002-7232-0594

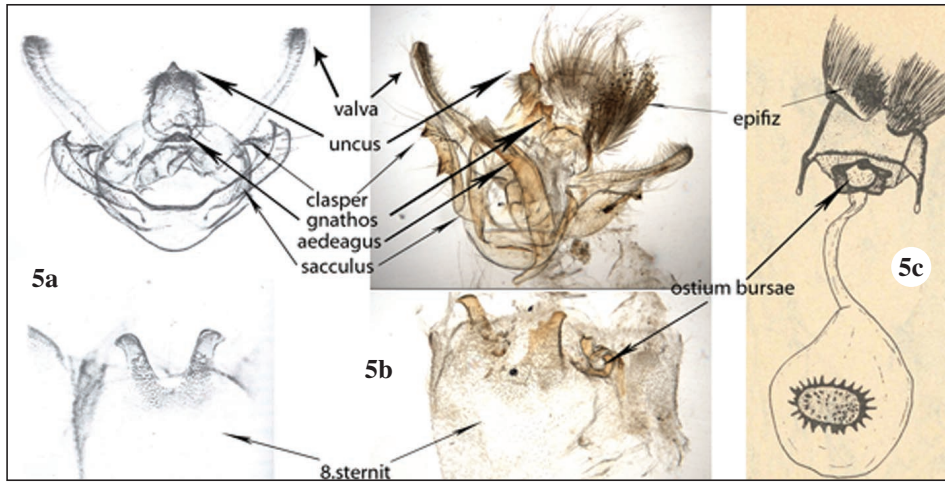
*Autor para la correspondencia / *Corresponding author*

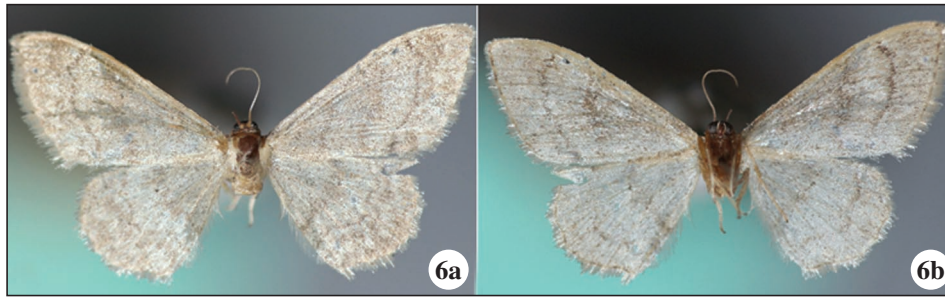
(Recibido para publicación / *Received for publication* 17-II-2016)
(Revisado y aceptado / *Revised and accepted* 17-V-2016)
(Publicado / *Published* 30-III-2017)



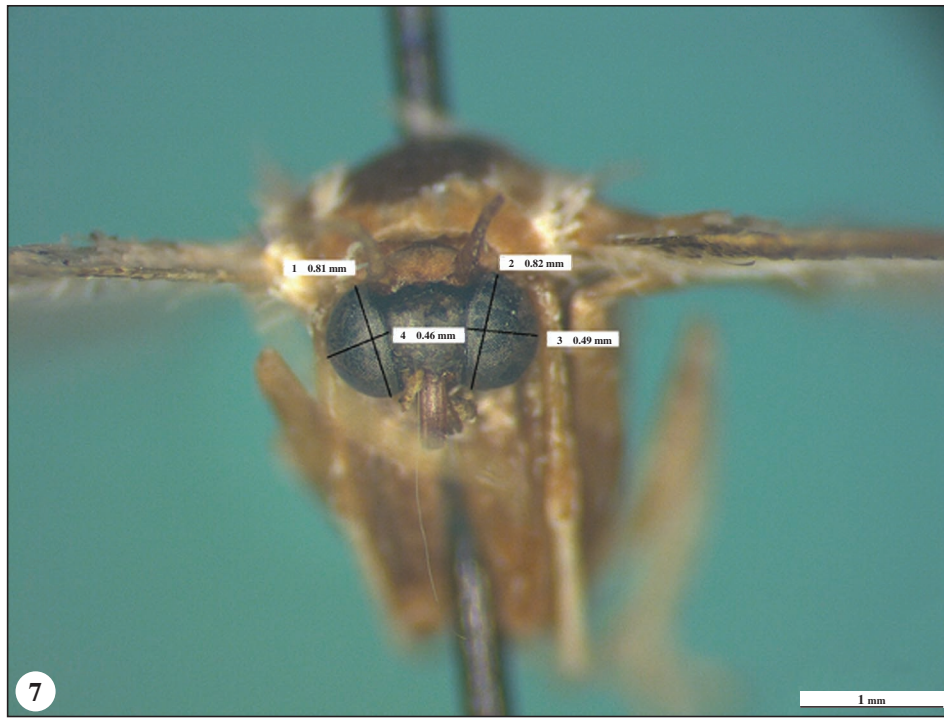
Figures 1-3.– 1. Habitus of gynandromorphic *Gnopharmia cholcidaria* (Lederer, 1870); **1a** upside, **1b**: underside. **2.** Eye measurements of gynandromorphic *Gnopharmia cholcidaria* (Lederer, 1870) (Right and left). **3.** Frenulum of gynandromorphic *Gnopharmia cholcidaria* (Lederer, 1870); **3a**: left, **3b**: right.



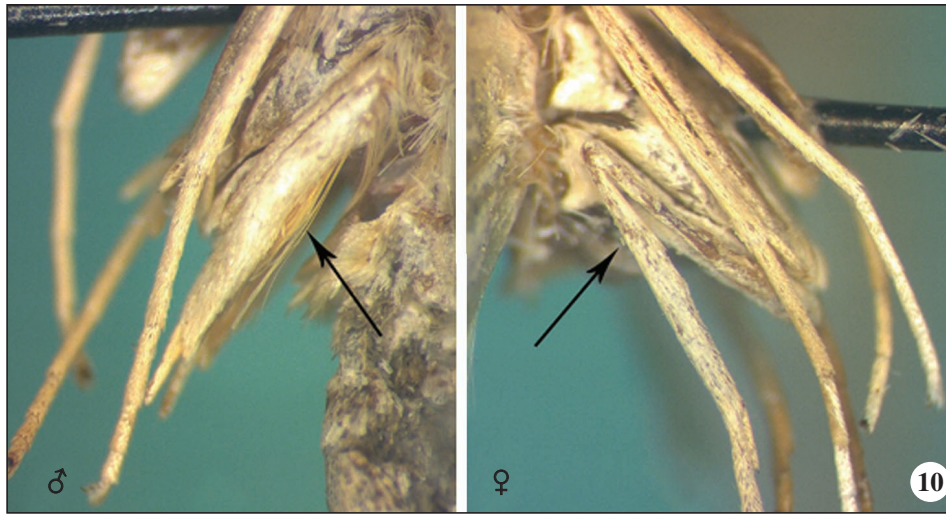




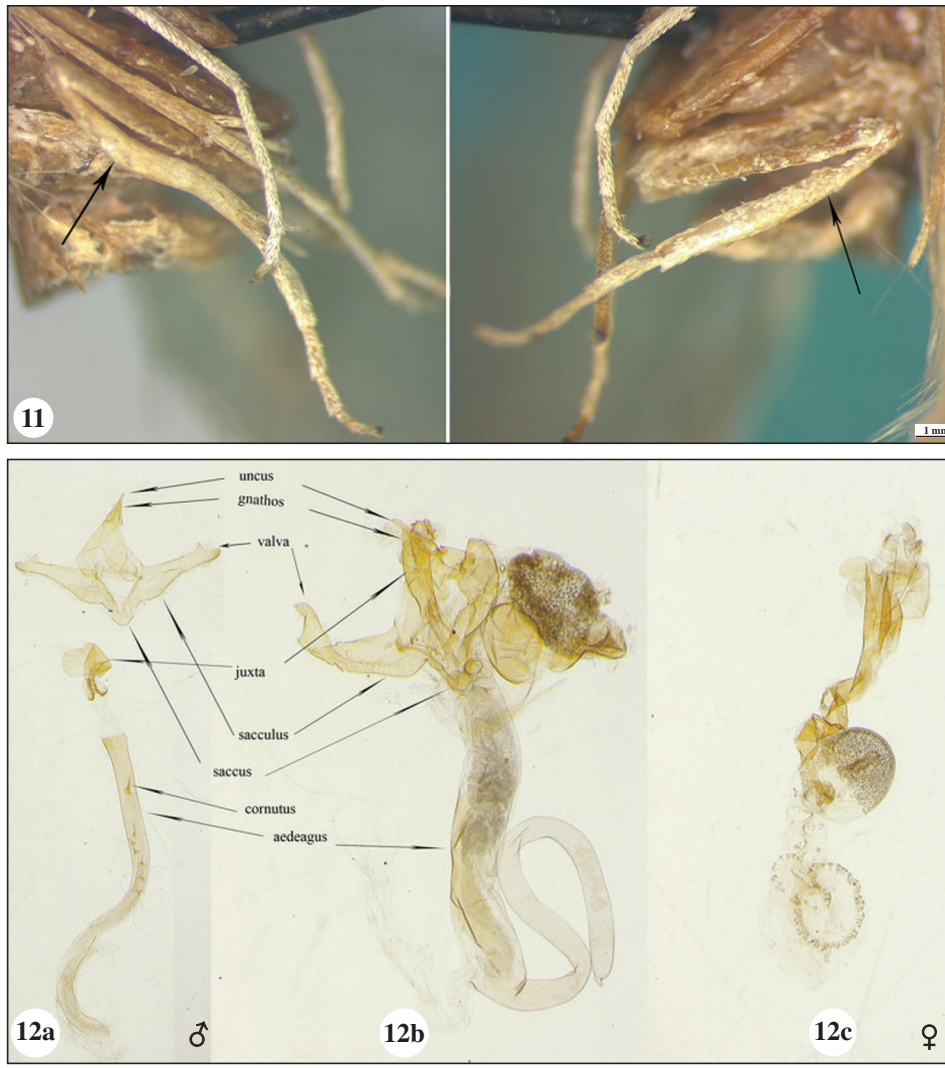
Figures 4-6.– 4. Wing measurements of gynandromorpic *Gnopharmia cholcidaria* (Lederer, 1870). **5.** Genitalia of gynandromorphic *Gnopharmia cholcidaria* (Lederer, 1870); **5a:** Male individual (SCOBLE & KRÜGER, 1999), **5b:** Gynandromorph individual, **5c:** Female Individual (WARDIKJAN, 1985). **6.** Habitus of gynandromorphic *Idaea deversaria* (Herrich-Schäffer, 1847). **6a:** upside, **6b:** underside).



Figures 7-8.– 7. Eye measurements of gynandromorphic *Idaea deversaria* (Herrich-Schäffer, 1847). **8.** Wing measurements of gynandromorphic *Idaea deversaria* (Herrich-Schäffer, 1847).



Figures 9-10.– 9. Frenulum of gynandromorphic *Idaea deversaria* (Herrich-Schäffer, 1847); **9a:** right, **9b:** left. **10.** Hindlegs of *Idaea deversaria* (Herrich-Schäffer, 1847) normal individual.



Figures 11-12.– 11. Left and right hindlegs of *Idaea deversaria* (Herrich-Schäffer, 1847) gynandromorph individual. **12.** Genitalia of *Idaea deversaria* (Herrich-Schäffer, 1847), **12a**: male individual, **12b**: gynandromoph individual, **12c**: female individual.