Atalanta (May 1994) **25**(1/2):245-259, Würzburg, ISSN 0171-0079

To the biology and morphology of Sphingonaepiopsis kuldjaensis GRAESER, 1892

(Lepidoptera, Sphingidae)

by

VADIM V. ZOLOTUHIN

received 3.VI.1993

Abstract: Data on biology and morphology of the preimaginal phases of development, with larval chaetotaxial maps, is given for rare and local middle-asiatic species, *Sphingonaepiopsis kuldjaensis* GRAESER. Some notes on the taxonomy within the *gorgoniades*-complex are presented.

Резюме: По материалу из Чаткальского биосферного заповедника (Узбекистан) изучены биология и морфология преимагиналъных фаз развития редкого и локального дорного спеднеазнатского бражника *Sphingonaepiopsis kuldjaensis* Graeser. Вид развивается в 2 частнчно перекрывающихся генерациях: лет бабочек с конца апреля по начало июля и в июле - августе. Плодовитость самки - несколько десятков яиц. Гусеницы на *Galium*, проходят 4 возраста. Куколка на поверхности почвы, зимует. Приведены схемы хетотаксии гусеницы и замечания по таксономии комплекса *gorgoniades*.

Hawk-moths of the genus *Sphingonaepiopsis* (type species *Lophura nana* WLK.) are the smallest Sphingidae belonging to the Palearctic fauna. Their biology and morphology is still relatively unknown even for the common and local western-palearctic species *Sphingonaepiopsis gorgoniades* HBN. At the same time the doubtfulness and confusion about the systematical status of such taxa as *chloroptera* MENTZER or *pfeifferi* ZERNY and their relationships with *gorgoniades* HBN. are bound by the absence of well investigated characters of a specific range of the moths of this genus. It is possible that a study of the middle-asiatic species *Sphingonaepiopsis kuldjaensis* GRAESER (the specific status of which is beyond doubt) would be useful in solving this problem.

Sph. kuldjaensis was collected in May and June 1992 in the Chatkal biosphere reserve of Uzbekistan (60 km ESE Tashkent) at an altitude of 1250m. Information on species distribution and phenology was added after the work on the collections of the Zoological Institute of Russian Academy of Sciences (St.-Petersburg), Zoological Museums of Moscow and Kiev State Universities, Institute of Zoology of Ukraine Academy of Sciences (Kiev) and the private collections of A. V. TSVETAEV (kept in Zool. Mus. of Moscow University) and A. I. IVANOV (St.-Petersburg) was carried out. It is my pleasant duty to express sincere thanks to those colleagues who helped me in this work, namely Mr. I. YU. KOSTJUK (Kiev), Dr. E. M. ANTONOVA and Dr. A. V. SVIRIDOV (Moscow). I am also deeply thankful to Dr. U. EITSCHBERGER (Germany, Marktleuthen) who sent me all the *Sphingonaepiopsis* from his collection for examination.

Sphingonaepiopsis kuldjaensis was described as *Pterogon* from Kuldja, NW China. Later it was repeatedly noticed in various papers of general character such as "Die Großschmetterlinge der Erde" or in the catalogues by various authors, but all the information in these books was only a repetition of description, and had only limited news about the biology and distribution of the species. DERZHAVETS (1984) summarized all the data about this in:

"*S. kuldjaensis* GRAESER, 1892, Berl. Ent. Ztschr., **37**:299 (*Pterogon*) Middle Asia (Thian-Shan, Pamiro-Alaj) - NW China. Till 3 generations. Caterpillar on *Galium* supposedly."

This data can be completed by the following:
Imago of the first generation (fig. 20): Forewing length 11 – 14 mm. Head almost triangular with a well developed front. Antennae bead-shaped with triquetrous segments. Palpi labiales 3-segmented, Palpi maxillares reduced and present only as one small segment. Thorax ash-grey. Wings have a toothed external edge. Venation typical for genus structure (fig. 1a): in the forewing common branch R2+3 and R4 and its origin close to that of R5; M1 free and weakly developed; origin of M2 close to that of M3; only one Cu present; A1 absent, A3 merged with A2. In the hindwing Sc makes an anastomosis with R by cross-vein; common short branch R and M1; origins of M3 and Cu1 moved apart; M2 weakly developed; three A-veins present, but A1 rudimentary.
The groundcolour of the forewing is grey with a clear pattern of black and scales. Within the genus there is a standard pattern for the wings (fig. 1b), consisting of the following markings (the terms used by SCHWANWITSCH, 1945): two dark basalis, B, two wide and clearly observed media, M, inner one connected with a white discal spot, faltering third externa, E3, and lunulated first externa, E1. They have complicated curvature and added by diffuse umbrae: two-separated umbra basalis, bU, wide umbra medialis, mU, faltering umbra ocellaris, oU, and spacious umbra externalis, eU. Umbrae have a grey or brownish-grey colour due to the presence on their fields of a large number of white scales. For that genus a black elongated intervenal strike between M2 and M3 is also typical. On the hindwing the basals are absolutely reduced, media and third externa are reduced until the small brown spots and the wide band formed by the first and second externae merge together with the umbra externalis.
The hindwings are fuscous-orange with a wide blackish-brown border and small plots of brown scales on a light background. The legs are long and thin, both the tibia and the tarsus possess short but strong setae; the foretibia has a leaf-shaped epiphysis and are half as long as the tibia; mesotibia with a pair of top-thorns; metatibia with a pair of top-thorns and pairs of ad-top ones. The abdomen is ash-grey with black and white scales on distal edges of tergites.
The imago of the second generation (fig. 21) is of the same size but lighter and the grey colour of the forewings is replaced by a reddish-brown.
Male genitalia (fig. 2b) is symmetrical, typical in the main for the family structure and characterized by the harpal appendix on inner surface of valva, the long curved tooth on lateral side of aedoeagus (fig. 2c) and the absence of cornuti on the vesica.
Female genitalia (fig. 2a) look like the same as those of *Sph. gorgoniades*. The anal lobes have some long and strong setae, antevaginal plate as band-forming sclerite; the antrum is sclerotized, ductus membraneous and smoothly transfering in the bursa. The bursa copulatrix is bug-shaped with elongated signum in the medial zone.

The phenology of *kuldjaensis* is represented in tabel 1. The earliest record that I have seen was from 8.IV.[189?], but in old style now, in Gregorian style, it would be 21.IV. (one female from Kuldja). THe latest record is from 1.IX.1936 (one Male from Tashkent) but the majority of moths were collected in May.

The natural observation on the field station of the Chatkal reserve show that usually only one full generation took place, the second generation was partial. But the flight of the G1 moths is very prolonged from middle of April until the beginning of July and partly overlaps with the G2 period. So the last moths of G2 can be met until September, which creates the wrong impression about the presence of a third generation. Even a percentage of the pupae of G1 formed at the beginning of July (about 10–15% of all G1 pupae) do not develop immediately, but hibernate.

Table 1· Phenology of *Sphingonaepiopsis kuldjaensis*

months	Apr			May			Jun			Jul			Aug			Sep			comments
decades	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
			x	x	x	x	x	x	x	x									
				▪	▪	▪	▪	▪	▪	▪	▪								about 10–15% of the
					–	–	–	–	–	–	–	–	–	–					1st generation hibernates
												o	o	o	o	o	o	o	o o o o o
								o	o	o	o	o							
										x	x	x	x	x	x				
											▪	▪	▪	▪	▪				2nd generation
												–	–	–	–	–	–	–	hibernates
															o	o	o	o	o o o o o

x – imago; ▪ – egg; – – larva; o – pupa.

Moreover, the overground parts of *Galium*, the larval foodplant, are almost completely dried by the sun up to the end of August, however. Migration of *S. kuldjaensis* in the lower parts of mountains was not observed. In the Chatkal reserve this species is not rare during May– June, and was absent in September–October.

Males fly from sunset to 4–5 a.m., the females fly after sunset to midnight and fasten their eggs on sprout tops of various *Galium* spp. singly or in pairs. Female fertility is only some tens of eggs – I achieved numbers of 12 and 29 from 2 moths, but in nature these figures are obviously greater.

Egg: Practical right sphere-shaped, about 1 mm in diameter, light-green with strong pearl lustre. When the embryo develops, the egg's colouration changed to greenish yellow. The eggs develop in about 7 days and the larvae hatched in twilight and ate all eggshell during 40–45 min.

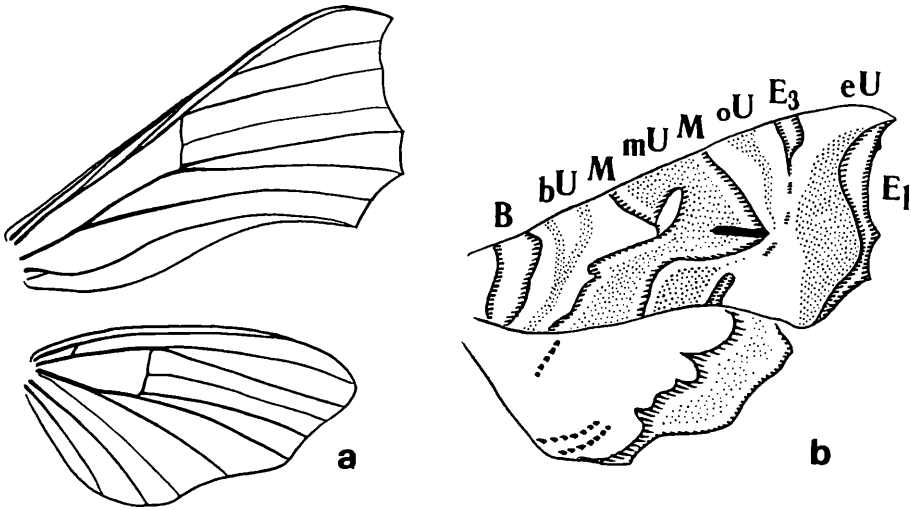


Fig. 1: a) venation of wings; b) pattern of wings.

Larva: L1 (fig. 3) just hatched are 3.5 mm long and grey-yellow-green. After an hour they become dark grey-green. The primary setae are well observed, black; the horn is small, about 0.8 mm, dark. The head is rounded and yellow-green in colour and the body has a tight and poorly observed subdorsal light line. The larvae are not mobile and eat after long pauses. They eat buds or nibble young leaves from the top, and older ones at the edges. The width of the head capsule is 0.65 mm. The first instar lasts 3 days and is up to 7 mm long.

Chaetotaxy of L1 larvae:
The head capsule (figs. 4a, b) has long, strong and well sclerotized setae and weakly widened tops (fig. 12a). The setae of the clypeal group move together and are situated in the usual position but C1 is much shorter than C2. The frontal seta F1 is situated on the side of the front in its inner third; adfrontal ones, Af, are slightly higher than the front and as long as F1. The setae anteriores are situated in the isosceles triangle where A1 heaved down largely and A2 and A3 are on one line with P2 and O2. Seta ommatalis O3 on one line with P2-L1-O2. SO2 and SO3 move off from other, SO1 is shorter than both other setae of subommatalis group. Microscopical G as single short seta is present. The microsetae of vertex group, V, were not observed. 6 ocelli are typical, ocellus 3 twice larger than others and ocellus 6 heaved down ventrally. The next punctures are present: Pa, La, Oa, Ga, SOa, SOb, SOc. The division of clypeus on the post- and anteclypeus is not noticable. Labrum with small cut, medial seta, M, in usual position (fig. 5a), lateral ones moved together and L2 much shorter than L1. Epipharyngial teeth (3 pairs) seen as clows. The mandibules (fig. 6a) are strong, wide, bucket-shaped, molar edge with six pyramidal flattened teeth with clear jags on the edges. The outer surface of the mandibule has 2

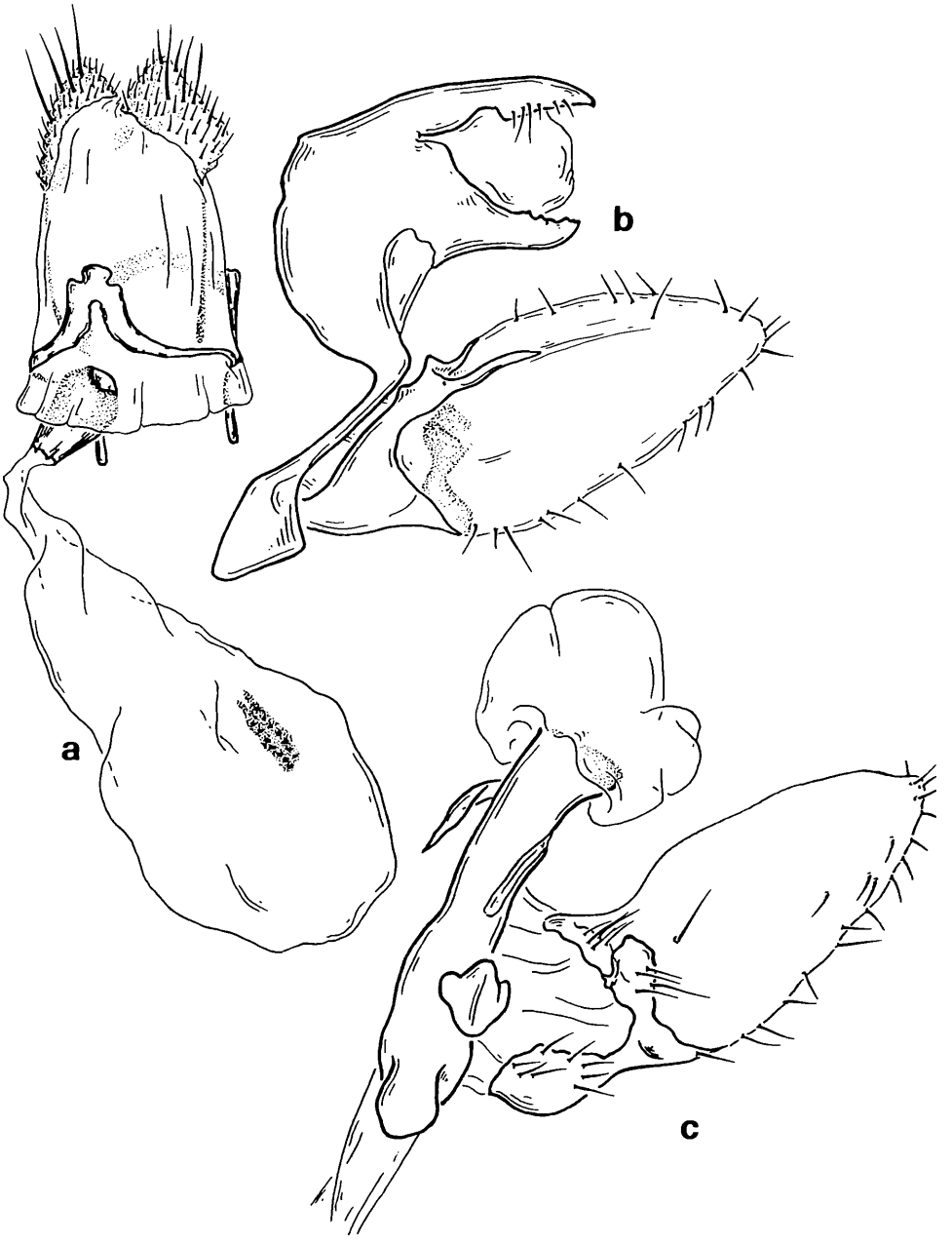


Fig. 2: a) female genitalia; b) male genitalia, side view; c) aedoeagus and valva inside.

setae. The Labiomaxillar complex and palpus maxillares are illustrated (figs. 7, 8a). The fusulus, or spinning teat, is undeveloped and is only present as a membraneous fold. It is possible that this can be explained by the abundant "glandular" secretion and large epidermal appendices of the larval foodplants, *Galium* spp., that ensure the secure attachment of larvae to a stem without the use of a silk gland. The epicranial index as ratio of front length to vertex sutura length is 2.0.

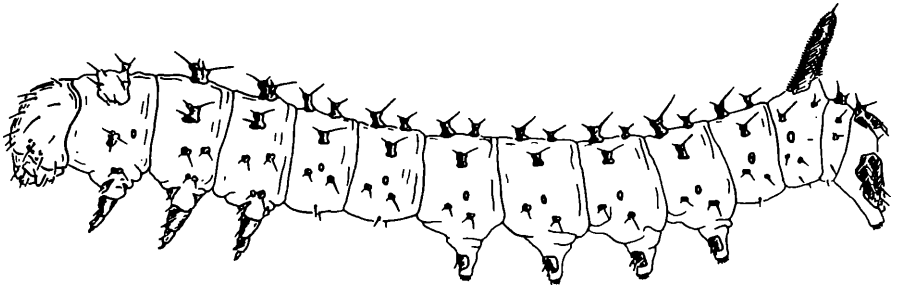


Fig. 3: Larva of first instar.

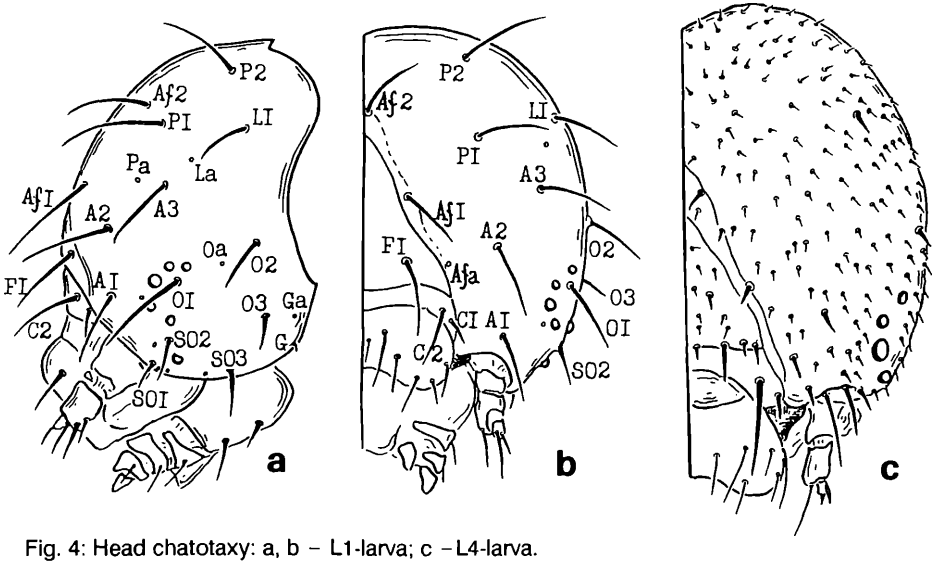


Fig. 4: Head chatotaxy: a, b – L1-larva; c – L4-larva.

Fig. 5–8: 5a) labrum of L1; 5b) labrum of L4. 6a) mandibula of L1; 6b) mandibula of L4. 7a) antenna of L1; 7b) top of antenna of L4. 8) labio-maxillar complex of L1, ventral view.

Body segments weakly granulated without microsetae and not a single microseta was found in spite of a special search. This is in difference to what has been written by HINTON (1946) who gave a combined scheme of setae distribution for the Sphingidae as a whole after studying *Sphinx ligustri* larvae.

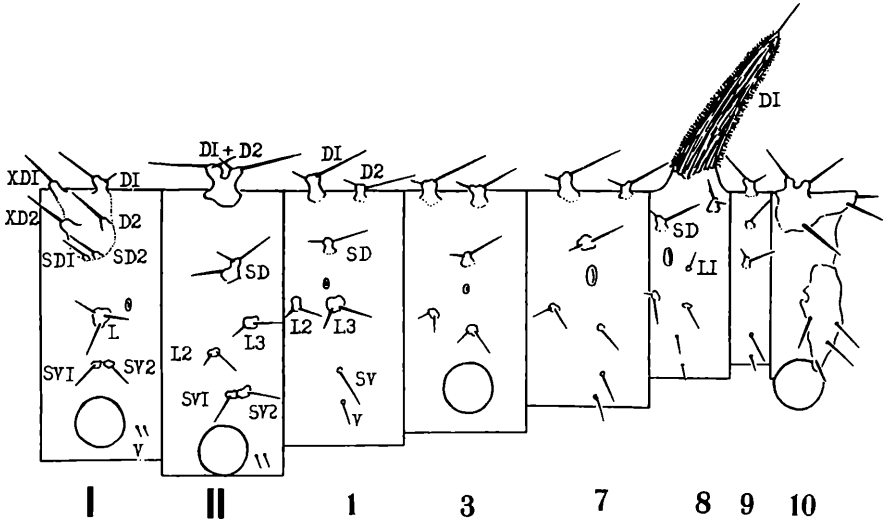


Fig. 9: chaetotactical map of body of L1.

Prothoracal corselet of *kuldjaensis* is small, poorly pigmented and bears 6 pairs of setae (fig. 9). Two pairs of them namely XD1 and D1 such as XD2 and D2 are situated on one line on both sides of the corselet. Subdorsal setae SD1 and SD2 are situated on its lower edge. The setae of the larval body are greatly transferred into strong sclerotized structures with typical foundations. The prothorax lateral setae sit on one foundation; supraventral setae SV1 and SV2 move together; ventral, V, without corselet and situated between back coxal edge of forlegs. The chaetotaxy of the mesothorax is identical with that of the metathorax. Dorsal setae D1 and D2 have a common basis (fig. 8b); subdorsal ones, SD, also merge. Lateral setae broken into 2 groups where back, L3?, almost twice as large as fore one, L2?. The situation of supraventral and ventral setae identical with that of the prothorax. The chaetotaxy of the thoracic legs is of the usual type (fig. 10a).
On abdominal segments 1–7, the setae dorsalis are separated and D1 is almost twice as large as D2. The subdorsal setae are on the common basis and the lateral setae are situated in 2 groups on both sides of the stigma. The supraventral and ventral groups are represented by one pair of setae on segments 1–2 and 7–8 and not observed on segments 3–6. The hooks of abdominal legs' sales situated in single one-tier mediorow (fig. 11a). The stigmae of segments 7 and 8 are twice as large as the other ones.

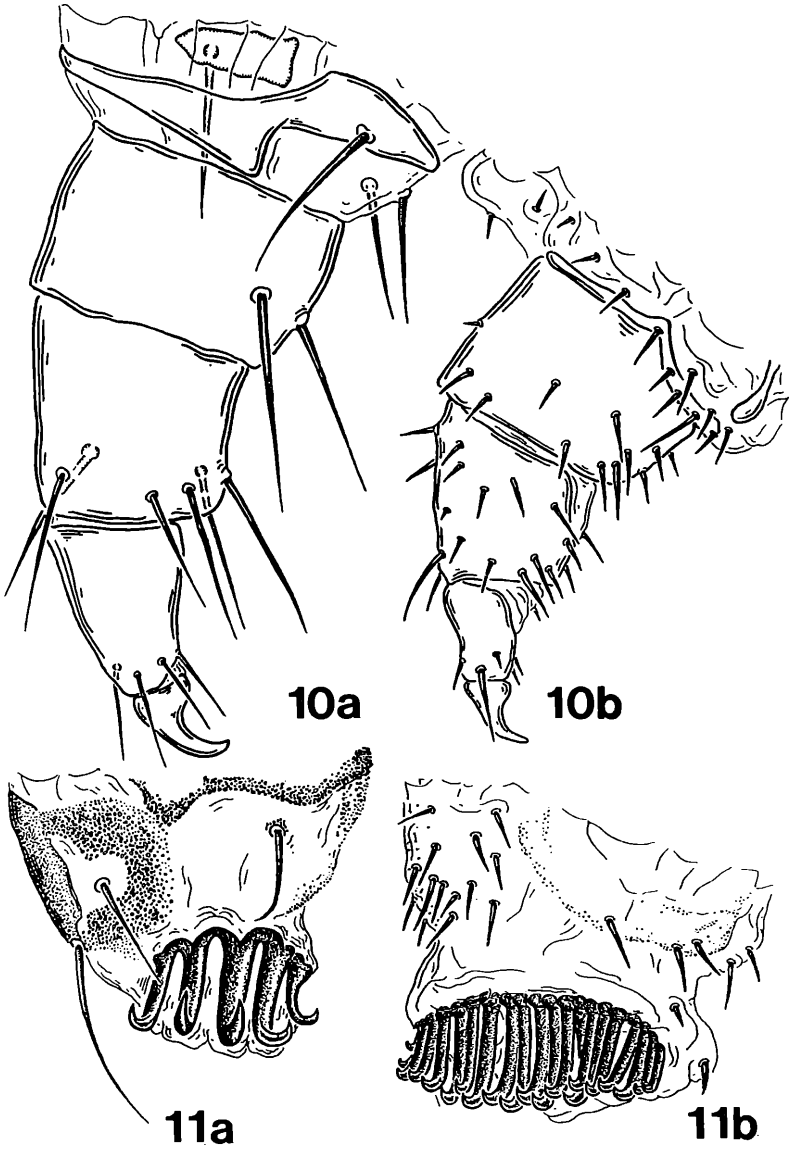


Fig. 10: a) mesothoracic leg of L1; b) the same of L4.
Fig. 11: a) abdominal leg of L1; b) the same of L4.

The horn is typical for abdominal segment 8. It is presented by both D1 setae and is covered by numerous small T- and Y-form setae (fig. 13a). D2 is ventrally haired and SD shifted cranially. There is also a small single seta beyond the stigma, I consider it as seta poststigmalis and attribute it to the setae of the lateral group, ?L1 Setae L2 and L3 also properly situated here on abdominal segment as on others.
On segment 9 I include to consider chaetotaxy as situated in one single vertical row setae D1+D2-SD-L-SV1-V1. The chaetotaxy of segment 10 was not specially studied, but it does not differ considerably from the typical lepidopteran scheme figured by GERASIMOV (1952).
Age changes in chaetotaxy are described in the part "chaetotaxy of L4 larva"

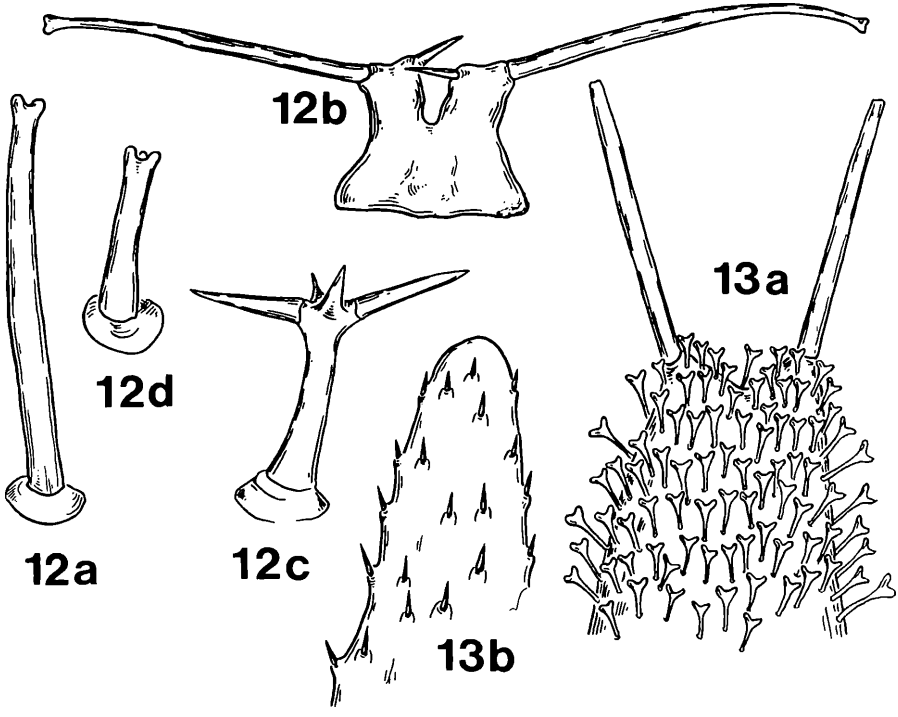


Fig. 12: a) head seta of L1; b) metathoracal seta D1+D2 of L1; c) body seta of L2 and L3; d) body seta of L4.
Fig. 13: a) horn top of L1; b) horn top of L4.

L2 larva: Larvae look *Hemaris* ssp. and have a grey-green body, green head and a straight bright black horn. The body has two whitish lateral lines: a wider substigmal and a narrow subdorsal one from the horn to the head. The black primary setae have given way to light secondary ones distributed in regular rows all over the body and look like an overturned

support (fig. 12c). Just moulted larvae are strikingly similar to young *Endromis*-larvae: the body is stretched, the first two pairs of abdominal legs are pursed, the top of the head is pulled into the thorax. The second instar lasts 3 days. The body length increases from 7 to 12.5 mm. The width of the head capsule is 1.0 mm.

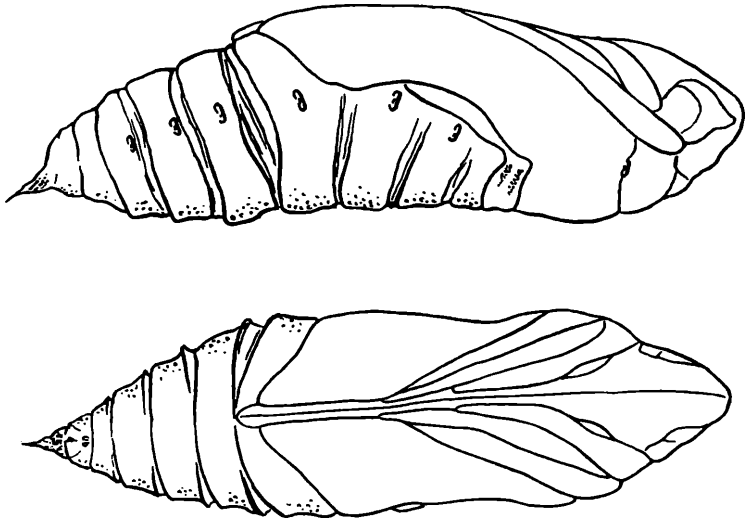


Fig. 14: pupa.

L3 larva: The colouration, pattern and form of secondary setae are as in L2-larvae, but the horn is violet-blue. The body length ranges from 12.5 to 22 mm; the width of the head capsule is 1.64 mm. About an hour after moulting the caterpillars ate their rinds and began to eat the foodplant. The third instar lasts 4–5 days.

L4 larva (fig. 16): The head and body are green-blue with small white tuberculae, the horn is violet-blue. The subdorsal line is narrow and weakly observed, the substigmal one is wide, white, or rose, or white with rose borders. The dorsal line cannot be seen. A rare colour variation was also observed in one caterpillar from the 30 specimens I have reared. The body (figs. 17, 18) had a rose and dark green bordered substigmal line; the dorsal and lateral surface of the segments are yellow-greenish. There are 8 sloping red-brown bands from the subdorsal line upwards, where they merge with the wide red-brown dorsal line. The horn is dark, the head is green. The ventral surface of the body has a light longitudinal line. The fourth instar lasts 8–10 days, the body length increases from 22 to 40 mm and the head capsule has a width of 2.15 mm.

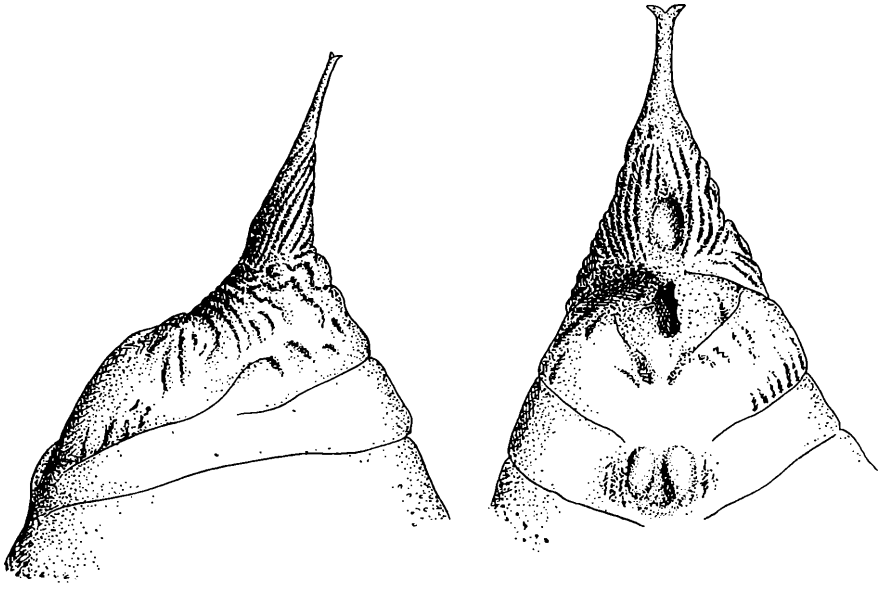
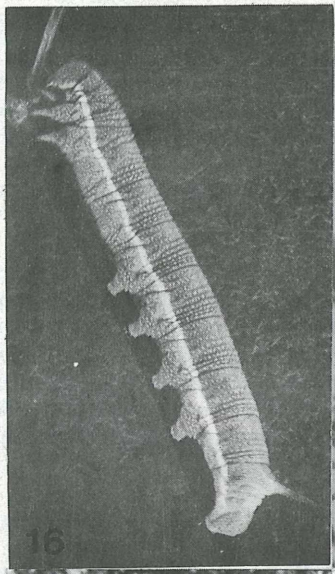
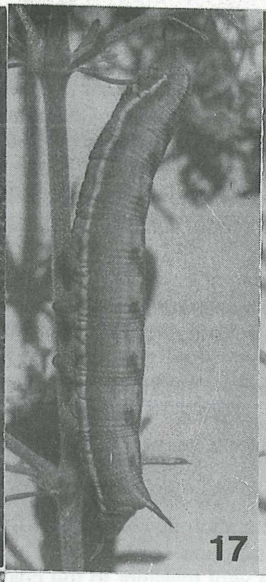


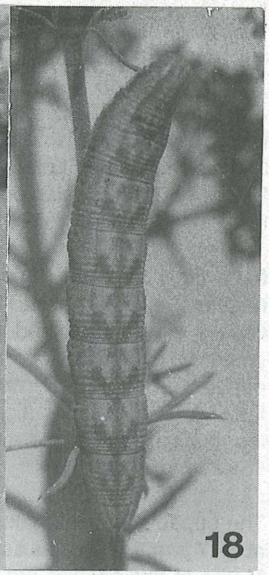
Fig. 15: cremaster.

Chaetotaxy of L4-larva:
This is characterized by the presence of a great number of secondary setae. The primary setae of the head (fig. 4c) can be identified only as stronger and longer ones among a lot of small light-coloured hairs and setae. The clypeus is divided on the ante- and postclypeus and deprived of secondary setae. C2 became very long and C1 reverse reduced to a large degree. F1 heaved down and situated on the border with the clypeus. Setae of adfrontal group shortened and Af1 dispersed one from another. Homologization of setae of A, P, O, SO and G groups is not possible reliably. Ocellus 5 is moved off the main group. The medial group of the labrum is shifted from the axis and the setae of the lateral group changed the situation one from another, M1 and L2 shortened. The chaetotaxy of the labio-maxillar complex is insignificantly changed. The serratedness of the mandibular teeth is smoothed over and they became curved and have massive central ribs (fig. 6b).

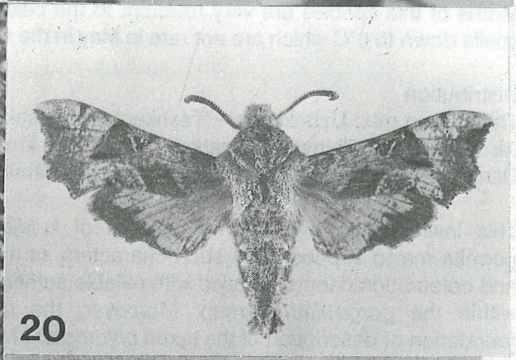
Fig. 16: L4-larva of typical colouration.
Figs. 17, 18: L4-larva of aberrant colouration.
Fig. 19: pupa.
Fig. 20: ♂ of the first generation.
Fig. 21: ♀ of the second generation.

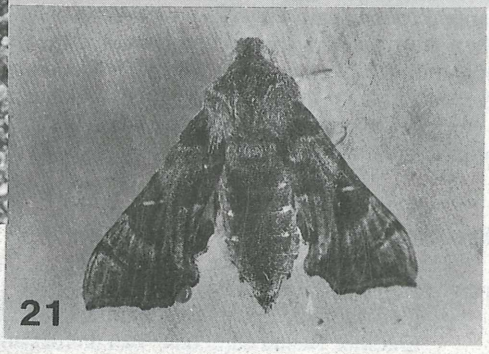

16


17


18


19


20


21

The entire body is covered by small light thorns which are situated on whitish tuberculae; the top of each thorn is enlarged and divided into 2 or 3 rounded tips (fig. 12d). The primary setae do not differ from each other and cannot be identified. The horn is smooth with single short strong thorns (fig. 13b). Chaetotaxy of the legs is also changed greatly (figs. 10–11b), the two-tier mediorow takes the place of the single mediorow of hooks on the abdominal legs' soles.
Before pupation the larvae became violet-reddish. The pupa is present under some leaves fastened together by silk threads. The pronymphal stage lasts about 3 days.

Pupa (figs. 14, 19) is slender, spindle-shaped, shining black, the abdominal intersegmental rings are orange-brown. The surface of the head and thorax is slightly wrinkled; proboscis case is slightly projected in front of the head which is typical for some Macroglossini; the antennae extend beyond the distal end of the prothoracic legs. The abdomen is densely punctated, the lateral margins of the 1–7th segment has grooves, and no spiracular furrows. Cremaster (fig. 15) is stretched, flattened dorso-ventrally with fringled longitudinally basis and a long top which is bifurcate at the tip. The length of the pupae is 18–23 mm.

The pupae of the first generation develop in 12–13 days. The moths hatch from the pupa at 6–7 p.m. Hibernates as a pupa.
Moths of this species are very resistent to the cold and can easily withstand heavy cold-spells down to 0°C which are not rare in May in the mountains where the species occurs.

Distribution
Thian-Shan mts: Uzbekistan – Tashkent and Tashkent environment (loc. Kumyshkan, loc. Ak-Tash), loc. Chimgan, Chatkal reserve (60 km ESE Tashkent); NW China (Kuldja). DERZHAVETS (1984) noted this species also for Pamiro-Altaj mts.

This investigation and the comparison of *kuldjaensis* with other *Sphingonaepiopsis* permits me to suppose that such characters as male and female genitalia, wing pattern and colouration cannot be used with reliable authenticity for the establishment of new taxa within the *gorgoniades*-group. Moreover, the character that had been laid in the foundation of description of the taxon *chloroptera* METZ., namely yellow hindwings, is not a taxonomic one because a yellow colouration of the hindwings and contrast in the forewing pattern are typical for the second generation of the *gorgoniades* on the whole. It is that synonymization of *chloroptera* with *gorgoniades* by DE FREINA & WITT (1987) seems to be very reasonable. At the same time good taxonomic characters probably could be found in the study of the preimaginal phases of development of these hawk-moths, especially in the caterpillars of the first instars.

References

DERZHAVETS, YU. A. (1984): An account of the clasification of the Sphinx moths (Lepidoptera, Sphingidae) with a list of species of the fauna of the USSR. Entomol. Revue **63**(3):604–620 (in russian).

FREINA, J. DE & T. WITT (1987): Die Bombyces und Sphinges der Westpalaearktis (Insecta, Lepidoptera). Band **1**. – München.

GERASIMOV, A. M. (1952): Caterpillars. Insecta: Lepidoptera. – Fauna SSSR, vol. **1**, no. 2(1), 338 pp (in russian).

HINTON, H. E. (1946): On the homology and nomenclature of the setae of the lepidopterous larvae, with some notes on the phylogeny of the Lepidoptera. – Trans. Royal Ent. Soc. London **97**(1):1–37.

SCHWANWITSCH, B. N. (1945): On the grounplan of the wing-pattern of Lepidoptera. – Zool. Zhurnal **24**(2):99–111 (in russian).

Adress of the author

VADIM V. ZOLOTUHIN
Biology Faculty, Entomology Dept.
University
Universitetskaja 7/9
199034 St.-Petersburg
Russia