



Formosan Entomologist

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Leucoblepsis taiwanensis sp. nov., a new species of Drepanidae from Taiwan (Insecta: Lepidoptera) 【Research report】

自台灣採集之鉤蛾科 (Drepanidae) (昆蟲綱: 鱗翅目) 的新種 *Leucoblepsis taiwanensis* 【研究報告】

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Received: 2001/12/21 Accepted: 2002/04/24 Available online: 2002/06/01

Abstract

Leucoblepsis taiwanensis sp. nov. is described from Taiwan and compared to other species of the genus. The new species is recorded from several localities in Taiwan. The known distribution is shown in a map. DNA sequences of the mitochondrial gene cytochrome oxidase subunit I are included in the character set.

摘要

本文敘述了隸屬於鉤蛾科 (Drepanidae) 的新種 *Leucoblepsis taiwanensis*，並與同屬之其他種類相比較。此種昆蟲分布於台灣各地。除形態上的差異外，本文亦利用粒線體基因cytochrome oxidase subunit I的核酸序列作為種別比較之用。

Key words: Lepidoptera, Drepanidae, *Leucoblepsis taiwanensis* sp. nov., Taiwan, distribution, DNA sequences, mtDNA, COI.

關鍵詞: Lepidoptera, Drepanidae, *Leucoblepsis taiwanensis* sp. nov., Taiwan, distribution, DNA sequences, mtDNA, COI.

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Leucoblepsis taiwanensis sp. nov., a new species of Drepanidae from Taiwan (Insecta: Lepidoptera)

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ABSTRACT

Leucoblepsis taiwanensis sp. nov. is described from Taiwan and compared to other species of the genus. The new species is recorded from several localities in Taiwan. The known distribution is shown in a map. DNA sequences of the mitochondrial gene cytochrome oxidase subunit I are included in the character set.

Zusammenfassung

Leucoblepsis taiwanensis sp. nov. wird aus Taiwan beschrieben und mit ähnlichen Arten dieser Gattung verglichen. Die neue Art ist an mehreren Plätzen in Taiwan gefunden worden. Die bisher bekannte Verbreitung wird in einer Karte dargestellt. DNA-Sequenzen des mitochondrialen Gens der Cytochromoxidase Untereinheit I werden in das Merkmalsset der neuen Art aufgenommen.

Key words: Lepidoptera, Drepanidae, *Leucoblepsis taiwanensis* sp. nov., Taiwan, distribution, DNA sequences, mtDNA, COI.

Introduction

The family Drepanidae is distributed predominantly in the Oriental region and more than 400 species are known (Heppner, 1991; Heppner and Inoue 1992; Holloway et al., 2001; Chu and Wang, 1991). Publications on some of the genera, e.g. by Watson (1957, 1961, 1968), Wilkinson (1967a, b; 1972), and Holloway (1998), respectively emphasize the need for further revision.

The genus *Leucoblepsis* is distributed

in the Oriental region from the Himalayas to Taiwan, and to Malaysia, Sumatra, and Borneo. However, in Watson's (1968) list of Chinese Drepanidae, the genus is not mentioned. Due to the huge distribution area of *Leucoblepsis excisa* (Hampson, 1893) which was described from India and is known from the Himalayas through Malaysia to Sumatra and Borneo but not recorded from China (Chu and Wang, 1991), it is likely that there are misidentifications and yet unrecognized

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unknown species included within that taxon.

For the Taiwanese fauna, there are at the moment 2 species of *Leucoblepsis* known, i.e., *L. excisa* (Hampson, [1893]), and *L. fenestraria* (Moore, 1868) (Heppner and Inoue, 1992; Wang, 1995). According to Inoue (1988) *L. fenestraria* (Moore, 1868) is a rare species in Taiwan.

The present work is a part of a large-scale study on the Drepanidae (e.g. Buchsbaum, 2000). In addition to investigations of museum materials drepanid moths were collected during several expeditions to Taiwan in different areas of the island. Detailed study of the specimens of the genus *Leucoblepsis* Warren 1922 revealed that they are a so far unknown species to science.

However, it seems that all Taiwanese specimens hitherto determined as *L. excisa* (e.g. Heppner and Inoue, 1992; Wang, 1995) represent the new species instead.

Abbreviations

The present work includes examinations of material from several museums and collections: BMNH (British Museum (Natural History), London, UK), FSCA (Florida State Collection of Arthropods, Gainesville, FL, USA), MWM (Museum Witt, Munich, Germany), NCH (National Chung-Hsing University Taichung, Taiwan), NMNS (National Museum of Natural Science, Taichung, Taiwan), ZFMK (Zoologisches Forschungsinstitut und Museum Alexander König, Bonn, Germany), ZSM (Zoologische Staatssammlung, Munich, Germany).

Leucoblepsis taiwanensis sp. nov.

(Fig. 1):

Holotype

male, S - Taiwan, KAOHSIUNG Co., Tengir Forest Res. Station, ca. 23°07'N, 120°47'E, 1600 m, 6-10-vii-

2000, leg. W. Schacht, coll. ZSM, later in coll. NCH Univ. Taichung. DNA-TAX voucher no. DNATA00568.

11 Paratypes:

- 1 female, NW Taiwan, Huesien Experimental Forest, 600 m, ca. 24°07'N, 121°03'E, E Taichung, 23-27-vi-2000, leg. W. Schacht, coll. ZSM, DNA-TAX voucher no. DNATA00573;
- 1 female, NW Taiwan, Huesien Experimental Forest, 600 m, ca. 24°07'N, 121°03'E, E Taichung, 23-27-vi-2000, leg. W. Schacht, coll. ZSM, DNA-TAX voucher no. DNATA00574;
- 1 female, NE-Taiwan, ILAN, Fushan Botanical Garden, 650 m, ca. 24°47'N, 121°33' E, 17-22-vi-2000, leg. W. Schacht, coll. ZSM;
- 1 male, S Taiwan, KAOHSIUNG, Tengir Forest Res. Station, ca. 23°07'N, 120°47' E, 1600 m, 6-10-vii-2000, leg. W. Schacht, coll. ZSM, DNA-TAX voucher no. DNATA00567;
- 1 male, S Taiwan, KAOHSIUNG, Tengir Forest Res. Station, ca. 23°07'N, 120°47' E, 1600 m, 6-10-vii-2000, leg. W. Schacht, coll. ZSM, DNA-TAX voucher no. DNATA00570;
- 1 male, TAITUNG, 7 km N Tupal, 120°52'E, 22°29'N, 500 m, 10-xii-1997, leg. S. Simony & A. Szabo, coll. MWM, DNA-TAX voucher no. DNATA00563;
- 1 female, Wulai, TAIPEI, 435 m, 20-22-ix-1992, leg. F. Aulombard & J. Plante, coll. ZFMK (Fig. 2);
- 1 male, TAICHUNG, Chaipautai, 8-10-v-1996, leg. C. S. Lin, coll. NMNS;
- 1 female, KAOHSIUNG, Liukuei Forest Station, 750 m, 29-iv - 3-v-1989, leg. J. B. Heppner & H. Wang, coll. FSCA;
- 1 female, Taiwan, HUALIEN, Wenshan spa, 580 m, 4-5-viii-1983, leg. A. Kawabe, coll. BMNH;
- 1 female, Wulei, TAIPEI, Formosa, 13-vi-1970, Y. Kishida, Coll. BMNH.

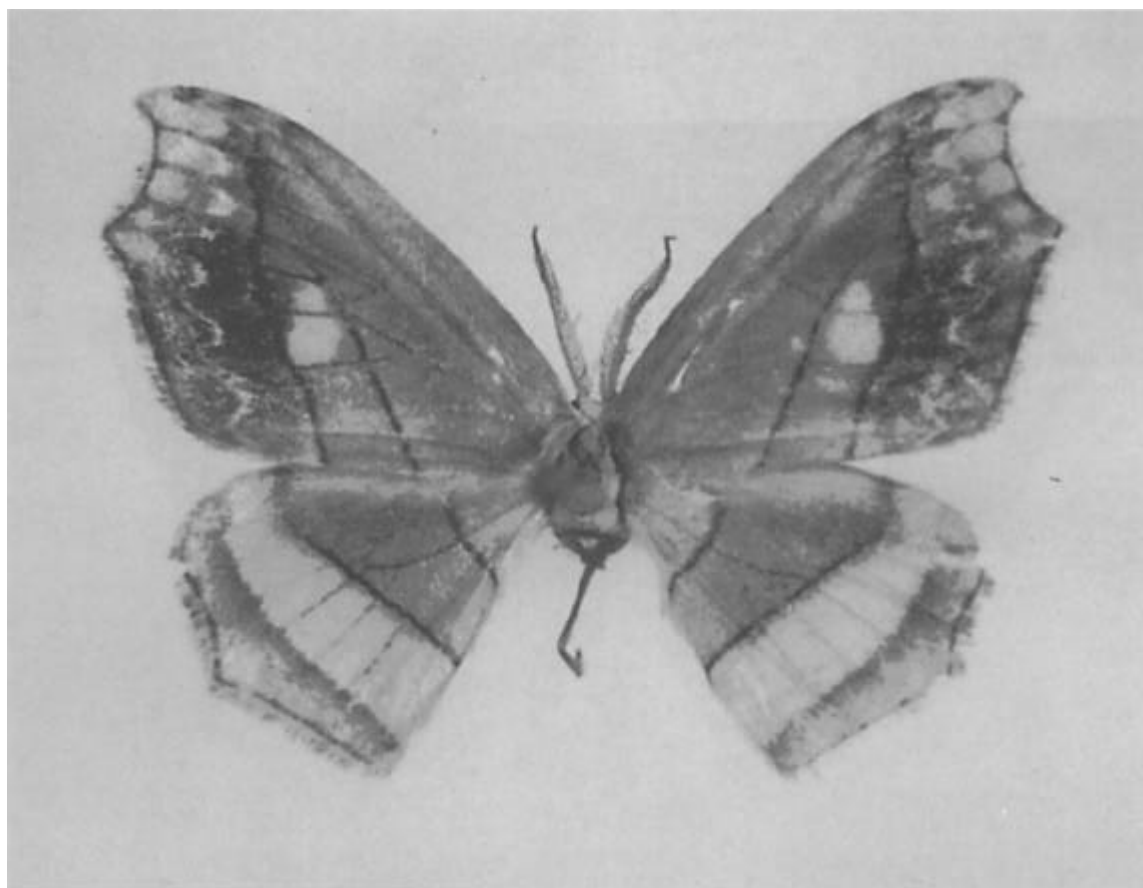


Fig. 1. Holotype, *Leucoblepsis taiwanensis* sp. n.

Description and differential diagnosis

Wingspan: 25-32 mm, \emptyset 28 mm; length of forewing: 14-17 mm, \emptyset 16 mm. Wingspan of the type *L. excisa*: 23 mm.

Somewhat resembling *L. excisa* but easily distinguished because *L. taiwanensis* sp. nov. is larger. On the forewing apex, the light-colored areas are larger and extend between R3 and M2 (in *L. excisa* only between R4 and M1) (for venation terms see Scoble, 1995).

Outer margin of forewing below apex half-moon shaped, more pronounced than in *L. excisa*. Both tips of the half moon shapes are more pointed in *L. taiwanensis* sp. nov., in *L. excisa* shallow, tips blunter. Submarginal blotch of

forewing distinctly darker in *L. taiwanensis* sp. nov. and extending median. Median fascia in forewing widening towards inner margin (in *L. excisa* not widening, running almost parallel). Scaleless areas between CuA1 and M2 forming a triangle in both species pointing to costal margin. Vein M3 cutting the triangle into 2 parts. In *L. taiwanensis* sp. nov. the triangle is larger and the cutted tip extending larger in cell M2 than in *L. excisa*.

Outer margin of hindwing lighter in *L. taiwanensis* sp. nov. than in *L. excisa*. Hindwing vein M2 prolonged to form a peak in the middle of the outer margin, in *L. excisa* less pronounced.



Fig. 2. Paratype, *Leucoblepsis taiwanensis* sp. n.

Male genitalia (Fig. 3a, b)

Uncus posteriorly rounded, more slender than in *L. excisa*. Vinculum stoutly sclerotized (in *L. excisa* distinctly narrower and slightly shorter). Valvae small and narrow, distally stoutly sclerotized, tapering (in *L. excisa* more pronounced than in *L. taiwanensis* sp. nov.). Saccus round (in *L. excisa* distinctly longer). Aedeagus slender. Carina as a broad spine. Ductus ejaculatorius narrow (in *L. excisa* distinctly wider).

Female genitalia (Fig. 4)

Ovipositor rounded, with only few

hairs. Antrum membranous, dotted. Ductus bursae very thin and tender. Signum little sclerotized and surface barely structured.

Genetic characterization

DNA was extracted from abdominal tissue of some of the type specimens of *L. taiwanensis* sp. nov. using a Qiagen (Hilden, Germany) tissue kit according to the manufacturers protocols. The mitochondrial (mtDNA) cytochrome oxidase subunit I (COI) gene was amplified with PCR using protocols and primers as in Simon et al., 1994. Direct sequencing of dye-labeled templates was carried out using an ABI 377 automated



Fig. 3. a. Holotype, male genitalia *Leucoblepsis taiwanensis* sp. n.; b. Holotype, male genitalia aedeagus *L. taiwanensis* sp. n.

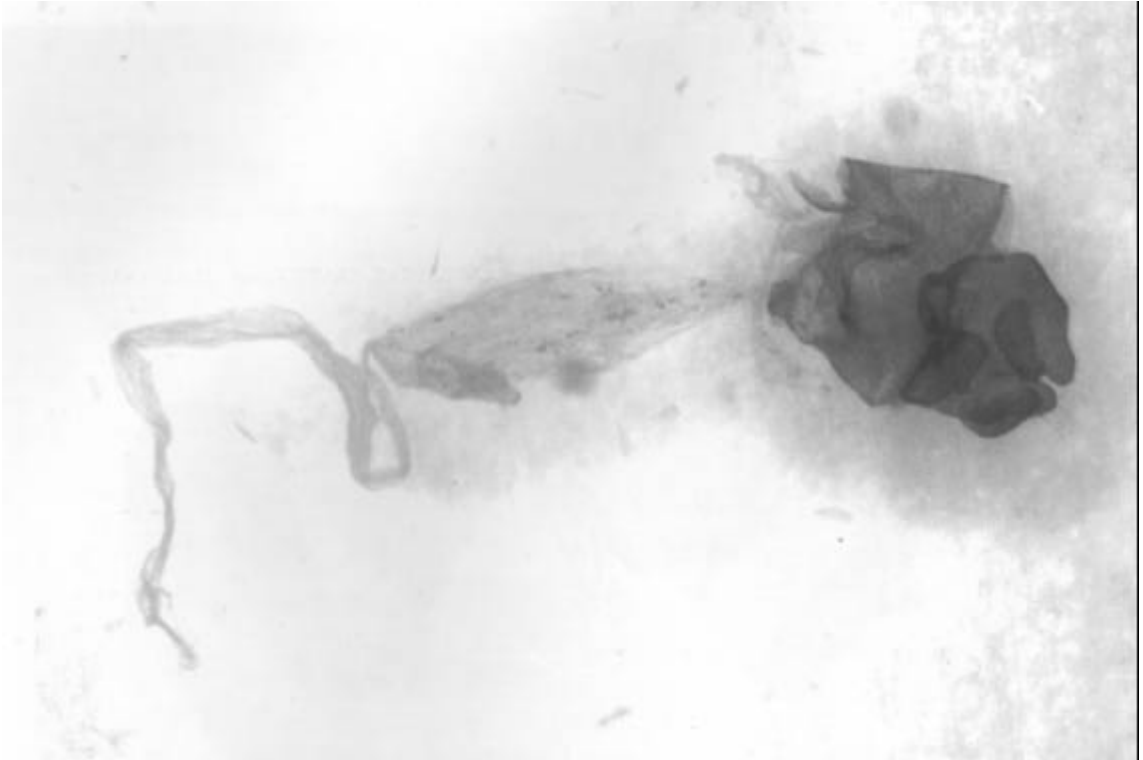


Fig. 4. Paratype, female genitalia *L. taiwanensis* sp. n.

sequencer (Applied Biosystems).

Up to 10 single sequences per individual were assembled and aligned to the COI gene of *Bombyx mori* (Lepidoptera, Bombycidae; GenBank accession no. NC_002355). Additionally we sequenced *Drepana falcataria* (DNATAX00481) for direct ingroup comparison (Fig. 5).

DNA is stored in the frozen DNA collection of the ZSM under storage numbers DNATAX00568 (holotype), DNATAX00563 (paratype), DNATAX00567 (paratype), DNATAX00570 (paratype), DNATAX00573 (paratype), and DNATAX00574 (paratype).

The following sequence of COI of the

holotype of *Leucoblepsis taiwanensis* sp. nov. (DNATAX00568) is aligned to the COI sequence of *Drepana falcataria* and the GenBank reference sequence of COI of the complete genome of the mitochondrion of *Bombyx mori* (NC_002355); (see page 107)

Species variation: In addition to the holotype we sequenced 5 of the paratypes. The sequence variation within the set of types is shown in Table 1. There are 17 variable sites within the paratypes and also 17 variable sites within all type specimens. Therefore the species variation is 1.09% sequence divergence in this set. For comparison of sequence divergence to other species within the

Position COI

	1	2	3	4	5
<i>L. taiwanensis</i> sp. nov.	CGAAAATGAC	TATACTCAAC	AAATCATAAA	GATATTGGAA	CCTTGTATT
<i>Drepana falcata</i>	.....T..T.....	.....	.....	.....T..A.....	.....
<i>Borbyx mori</i>	.....A..T..T..T..	.....	.....	.....A..A.....	.....

Position COI

	6	7	8	9	10
<i>L. taiwanensis</i> sp. nov.	TATTTTGGGA	ATTTGAGCAG	GAATAGTAGG	AACATCTTTA	AGACTATTAA
<i>Drepana falcata</i>	...C.....	.....T..T..	.....A..T..	...T..A...	..TT.....
<i>Borbyx mori</i>	.....T.....	.....T.....	.....A..T..	.....	.....T.....

Position COI

	1	2	3	4	5
<i>L. taiwanensis</i> sp. nov.	TTCGAGCTGA	ATTAGGAAAT	CCAGGATCAT	TAATTGGAGA	TGATCAAATT
<i>Drepana falcata</i>	...T..A..	.....T.....	..T.....T..	.....A.....	.....
<i>Borbyx mori</i>	.....	.....	.....	.....	.....

Position COI

	6	7	8	9	10
<i>L. taiwanensis</i> sp. nov.	TATAACACTA	TTGTAACAGC	ACATGCTTTC	ATTATAATTT	TTTTTATAGT
<i>Drepana falcata</i>	.....T.....	.....T.....	T.....T.....	.....	.....
<i>Borbyx mori</i>	.....T.....	.....	.....T.....	.....	.....

Position COI

	1	2	3	4	5
<i>L. taiwanensis</i> sp. nov.	GATGCCAATT	ATAATCGGAG	GATTTGGTAA	TTGATTAGTG	CCTTTAATGT
<i>Drepana falcata</i>	T..A..T..	.....T.....	.....A.....	.....A.....	..A.....A..
<i>Borbyx mori</i>	-..A..T..	.....T.....	.....A.....	.....T.....	..C..T..AC

Position COI

	6	7	8	9	10
<i>L. taiwanensis</i> sp. nov.	TAGGTGCCCC	CGATATAGCT	TTCCCCGAA	TAAATAACAT	AAGATTTTGA
<i>Drepana falcata</i>	...A..G..	A.....G.....	..T..A.....	.....T.....	.....
<i>Borbyx mori</i>	...A..A..	-.....A.....	.....A.....	.....T.....	.....

Position COI

	1	2	3	4	5
<i>L. taiwanensis</i> sp. nov.	ATACTACCAC	CATCTTTAAC	TTTATTAATT	TCAAGAAGAA	TTGTAGAAAA
<i>Drepana falcata</i>	.....C.....	..T.....	..C.....	.....	..C.....
<i>Borbyx mori</i>	C..C.....C..	..C..CC..T..T	.....	.....	.....

Position COI

	6	7	8	9	10
<i>L. taiwanensis</i> sp. nov.	CGGAGCAGGA	ACTGGATGAA	CTGTCTACCC	CCCACTTTCA	TCTAATATTG
<i>Drepana falcata</i>	T.....T...	.....	.....G.....	.....	.....
<i>Borbyx mori</i>	T..T.....	..A.....	..A..T.....	.....	.....C.....

Position COI

	1	2	3	4	5
<i>L. taiwanensis</i> sp. nov.	CCCATAGAGG	AAGATCAGTT	GATCTTGCTA	TTTTTCTTTT	ACACTTAGCC
<i>Drepana falcata</i>	..T...G....	...C..T..A	.....	.....A.....	..T.....T
<i>Borbyx mori</i>	..A.....	.....C..A	.....	.....AC..	-..T.....A

Position COI

	6	7	8	9	10
<i>L. taiwanensis</i> sp. nov.	GGTATTTTCA	CAATTTTAGG	AGCAATTAAT	TTTATTACAA	CAATTATTAA
<i>Drepana falcata</i>	..A.....	.....	.....T.....	.....	.....
<i>Borbyx mori</i>	.....	.....A.....	.....	.....	.....A.....

Position COI

	5	2	3	4	5
	1	0	0	0	0
<i>L. taiwanensis</i> sp. nov.	TATACGATTA	AATAATATAA	GATTTGATCA	AATACCATTA	TTGTTTGAG
<i>Drepana falcataria</i>	.....	.....	T.....	.....CC..	.....
<i>Banbyx mori</i>	-.....	.....T C.....	.....T.....C..	.....A.....	

Position COI

	5	7	8	9	6
	2	0	0	0	0
<i>L. taiwanensis</i> sp. nov.	CTGTTGGAAT	TACAGCTTTT	TTATTATTAC	TTTCTTTACC	AGTATTAGCC
<i>Drepana falcataria</i>	.A..A.....	.....	.....	.....AC.C..	T..T.....A
<i>Banbyx mori</i>	...A..G..	-.....A...	.....T	.A..AC....	T..T.....T

Position COI

	6	2	3	4	6
	1	0	0	0	5
	0	0	0	0	0
<i>L. taiwanensis</i> sp. nov.	GGAGCTATTA	CAATATTATT	AACTGACCGA	AATTTAAATA	CATCTTTTTT
<i>Drepana falcataria</i>	.....	.C...C.TC.	T..A..T...	.....	.....A.....
<i>Banbyx mori</i>	.....	.....	-.A..T...	..C.....	.....A.....

Position COI

	6	7	8	9	7
	4	0	0	0	0
	0	0	0	0	0
<i>L. taiwanensis</i> sp. nov.	TGATCCTGCT	GGAGGAGGAG	ATCCAATTTT	ATATCAACAT	TTATTTTGAT
<i>Drepana falcataria</i>	.....	.....	.....	.....	.....
<i>Banbyx mori</i>	.....	.....	.C.....-	T.....	.....

Position COI

	7	2	3	4	7
	1	0	0	0	5
	0	0	0	0	0
<i>L. taiwanensis</i> sp. nov.	TTTTTGACA	TCCAGAAGTA	TATATTTTAA	TTTACCCGG	ATTGGGTATA
<i>Drepana falcataria</i>	.....G..	...T.....	.....	.....	.....G...
<i>Banbyx mori</i>	.....	...T.....T	.....	.....A..	-.....

Position COI

	7	7	8	9	8
	6	0	0	0	0
	0	0	0	0	0
<i>L. taiwanensis</i> sp. nov.	ATTTACATA	TTATTTACATA	AGAAAGAGGA	AAAAAGGAAA	CTTTGGGATG
<i>Drepana falcataria</i>	.....T..C.	.....T..	.....	.....A....	.A.....T..
<i>Banbyx mori</i>	.....T.....	.....	.....	.....A....	.....T.....

Position COI

	8	2	3	4	8
	1	0	0	0	5
	0	0	0	0	0
<i>L. taiwanensis</i> sp. nov.	TTTAGGAATA	ATTTATGCTA	TAATAGCAAT	TGGTTTATTA	GGGTTTATFG
<i>Drepana falcataria</i>	.....G...	.....	.....	..A.....	..A.....
<i>Banbyx mori</i>	.....	.....	..C.....	..G.....	..A..C....

Position COI

	8	7	8	9	9
	6	0	0	0	0
	0	0	0	0	0
<i>L. taiwanensis</i> sp. nov.	TTTGAGCTCA	TCACATATTT	ACAGTAGGAA	TAGATATTGA	TACTCGAGCT
<i>Drepana falcataria</i>	.....	.....T.....C	.....T.....	.....	.....C.....
<i>Banbyx mori</i>	.....	.....T.....C	..T.....T.	.....	..A.....A

Position COI

	9	2	3	4	9
	1	0	0	0	5
	0	0	0	0	0
<i>L. taiwanensis</i> sp. nov.	TATTTTACAT	CAGCAACAAT	AATTATTGCT	GTTCCAACAG	GAATTAATAAT
<i>Drepana falcataria</i>	.....G..	...T..T..	.....C	.....T.	.....
<i>Banbyx mori</i>	.....T.	...T..T..	-.....	..A.....	.....

Position C01

		9	1	8	5	1	0
		6	0	0	0	0	0
		0					
<i>L. taiwanensis</i> sp. nov.	TTTTAGTTGA	TTAGCTACAT	TCCACGGAAC	TCAAATTAAC	TATAATCCCT		
<i>Drepana falcata</i>	...C..A...	.....A..T.....	.....T.....	.....GA..T..			
<i>Bombyx mori</i>	.....A...	C.....A	.A..T.....	-.....T	.....C..TA		

Position C01

		1	2	3	4	1	1
		0	0	0	0	0	0
		1					
<i>L. taiwanensis</i> sp. nov.	CAACATTATG	AAGATTAGGA	TTGTATTTT	TATTACAGT	AGGGGGATTA		
<i>Drepana falcata</i>	.....C.....	.....T.....	.....A.....	.....A.....			
<i>Bombyx mori</i>	AT.TT.....	.....T	.....C.....	-..A.....			

Position C01

		1	1	2	2	1	1
		4	0	0	0	0	0
		0					
<i>L. taiwanensis</i> sp. nov.	ACAGGGGTTG	TATTAGCAAA	TTCTTCTATT	GATATTACCC	TTCATGATAC		
<i>Drepana falcata</i>	.....A.....	.....T.....	.....A.....	.....T.....	.....A.....		
<i>Bombyx mori</i>	.....T..AA	.T.....C..	.....AT	.A.....			

Position C01

		1	2	3	4	1	1
		1	0	0	0	0	0
		1					
<i>L. taiwanensis</i> sp. nov.	ATACTATGTA	GTAGCCCAT	TTCACTACGT	ATTATCTATG	GGAGCAGTAT		
<i>Drepana falcata</i>	T..T.....	.....T..T..	.C.....	.....A..T..			
<i>Bombyx mori</i>	T-.T.....	.....T.....	.....T..T..	TC...A..A	.....	

Position C01

		1	7	8	9	1	2
		4	0	0	0	0	0
		0					
<i>L. taiwanensis</i> sp. nov.	TTGCTATTAT	AGCCGGATT	GTTTCATTGAT	ATCCATTATT	TACAGGACTA		
<i>Drepana falcata</i>	.....A.....	A...C..G.	.....T.....	.....T...T..			
<i>Bombyx mori</i>	.....A.....	G.G.....	A..A.C.....	.....T.....	.....C..T		

Position C01

		1	2	3	4	1	2
		8	0	0	0	0	0
		1					
<i>L. taiwanensis</i> sp. nov.	TCTTTAAAGC	CATTATAT	AAAAATTCAA	TTTTTTATTA	TATTTTTAGG		
<i>Drepana falcata</i>	.....T..	.T...T..C.	.....	.....	.....
<i>Bombyx mori</i>	..A.....TT	.T.A...C.	.....	.....CA.	.....A.T..		

Position C01

		1	2	3	4	1	3
		6	0	0	0	0	0
		0					
<i>L. taiwanensis</i> sp. nov.	GGTAAATTTA	ACTTTTTTTC	CCCAACATT	TTTAGGGTTA	GCAGGAATAC		
<i>Drepana falcata</i>	T.....	.....T.....	.....T.....	.....T...T..			
<i>Bombyx mori</i>	A.....A..	.A.....	.A.....	.....T...T..	.....T.....		

Position C01

		1	2	3	4	1	3
		1	0	0	0	0	0
		1					
<i>L. taiwanensis</i> sp. nov.	CTCGAGGATA	TTCTGATTAC	CCAGATGCTT	ATATCTCCTG	AAATATAATT		
<i>Drepana falcata</i>	.....C.....	.....T.....	.....A.....	.....A.....	.....T.....		
<i>Bombyx mori</i>	.....A.....	.....T.....	.....CT.A.	.....T..A..	.....	

Position C01

		1	7	8	9	1	4
		4	0	0	0	0	0
		0					
<i>L. taiwanensis</i> sp. nov.	TCTTCTTTAG	GGTCATATAT	TTCATTATTA	GCAGTAATAT	TAATTTTAAT		
<i>Drepana falcata</i>	..A.....	.A..T.....	C..T.....	.....T...A	.....	
<i>Bombyx mori</i>	.....A.....	.T.....	.....TC.....	T.....A	.....A.....		

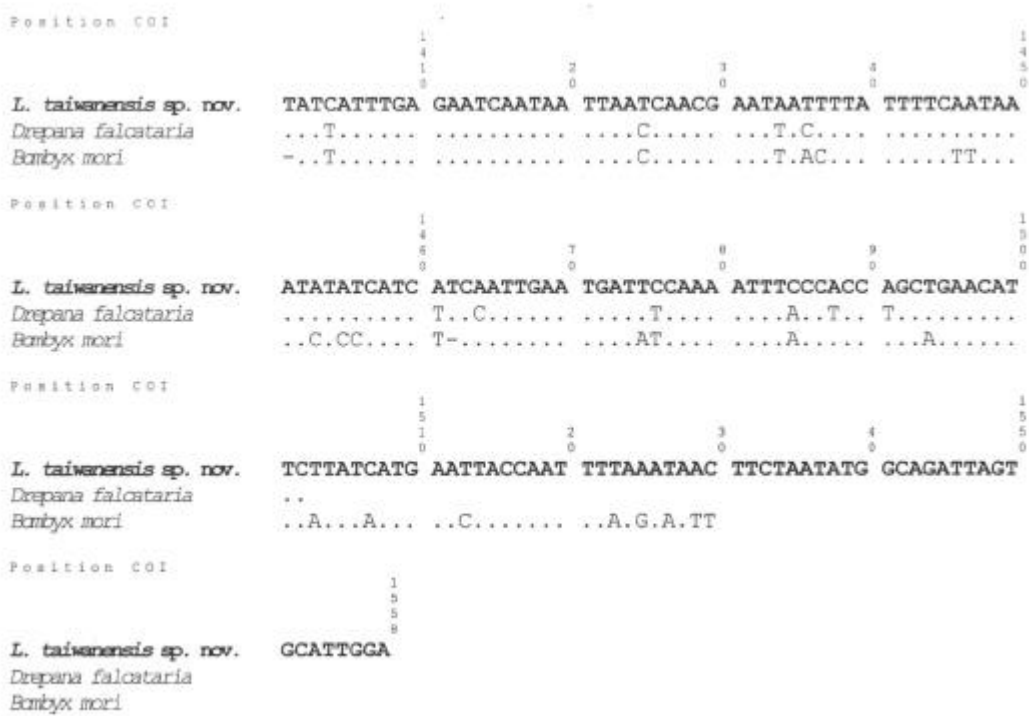


Fig. 5. The sequences of COI gene in *L. taiwanensis*, *Drepana falcataria*, and *Bombyx mori*.

subfamily Drepaninae we counted the variable sites between *L. taiwanensis* sp. nov. (Holotype, DNATA00568) and *Drepana falcataria* (DNATA00481). There are an over all 154 variable sites

in the 1502bp fragment of COI available for comparison, i.e., 10.25% sequence divergence within this part of the COI gene in the investigated specimens. Compared to a 1530pb fragment of COI of

Table 1. Variable sites and positions

variable sites positions COI	66	255	258	402	708	747	979	999	1083	1098	1198	1287	1308	1314	1319	1362	1404
DNATA00568 (holotype)	A	T	C	C	A	T	A	C	T	T	C	G	A	T	A	G	C
DNATA00563 (paratype)	A	A	A	T	A	T	G	T	T	C	T	G	A	T	A	G	T
DNATA00567 (paratype)	G	A	A	T	A	T	A	T	T	C	T	G	T	A	C	G	T
DNATA00570 (paratype)	A	T	C	C	A	T	A	C	T	T	C	G	A	T	A	G	C
DNATA00573 (paratype)	G	T	C	T	A	G	A	C	T	C	T	A	A	T	A	G	T
DNATA00574 (paratype)	G	T	C	T	G	T	A	C	C	C	T	G	A	T	A	A	T

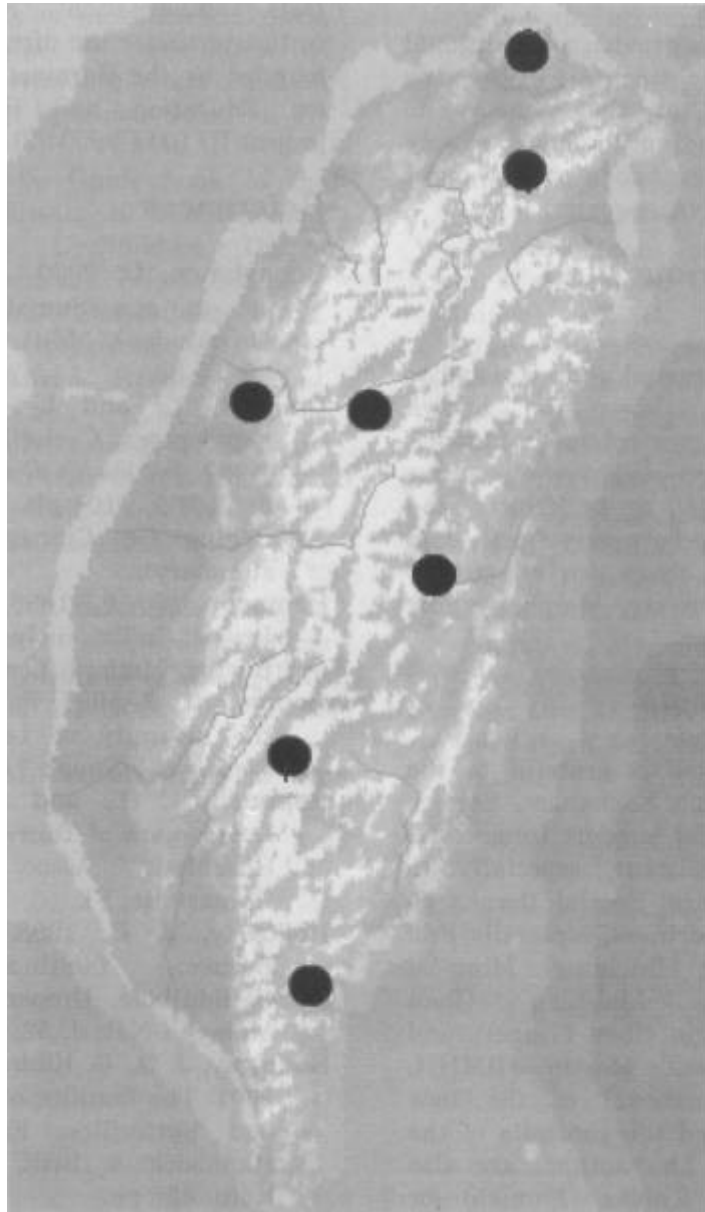


Fig. 6. The known distribution of the new species *L. taiwanensis* in Taiwan

B. mori (NC_002355) it is 13.79%.

The new sequences are deposited under the accession numbers AJ 458333 (DNATAX00568, holotype), AJ 458331 (DNATAX00563, paratype), AJ 458332 (DNATAX00567, paratype), AJ 458334

(DNATAX00570, paratype), AJ 458335 (DNATAX00573, paratype), AJ 458336 (DNATAX00574, paratype), and AJ 458337 (DNATAX00481, no type), respectively, at EBI/GenBank.

Remarks on molecular studies

Our aim was to provide an additional character set in the diagnosis of the new species. There is at the moment no possibility of including the most closely related species, *L. excisa*, in a differential diagnosis at the DNA sequence level.

Biology, behaviour, and distribution

Adults are nocturnal and attracted to light. Figure 5 shows the known distribution of the new species in Taiwan. The species has been caught at elevations of between about 400 up to 1600 m, and in most months between April and December. So far, there are no records from January, February, March, August and November.

Acknowledgments

The first author is grateful to the German Academic Exchange Service (DAAD) for financial support (project ID D/0039914, PPP-Taiwan), especially to Mrs. Eberlein (Bonn). Special thanks go to our Taiwanese partners, especially Prof. Dr. Jeng-Tze Yang (Taichung), Ming-Yu Tsai (Taichung), Mei-Ling Chan (Taichung), Keh-Miin Chen (Taipei), and many others. Geoff Martin (BMNH, London) loaned material of the new species and prepared the genitalia of the type of *L. excisa*. The authors are also grateful to Sonja Knölke (Munich) for preparing the genitalic slides and Martin Spies for his help with the translation.

Moreover authors thank Silvia Wagner and Konstantin Witt of the Sequencing Unit of DNA-TAX group for the laboratory works (Munich, ZSM).

The genetic part of this paper, conducted at the Zoologische Staatssammlung Munich, Germany, was part of the DNA-TAX project aimed at establishing insect sequence databases.

The project is part of the "Entomological Data Information System (EDIS)" initiative under the direction of BIOLOG, founded by the German Federal Ministry for Education and Research (BMBF project ID 01LC99004/2).

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Received Dec. 21, 2001

Accepted April 24, 2002

自台灣採集之鉤蛾科 (Drepanidae) (昆蟲綱: 鱗翅目) 的新種 *Leucoblepsis taiwanensis*

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摘 要

本文敘述了隸屬於鉤蛾科 (Drepanidae) 的新種 *Leucoblepsis taiwanensis*，並與同屬之其他種類相比較，此種昆蟲分布於台灣各地。除形態上的差異外，本文亦利用粒線體基因 cytochrome oxidase subunit I 的核酸序列作為種別比較之用。