



Thrips fauna on mountainous regions in Taiwan Island, with description of a new species from montane areas, *Thrips hehuanshanensis* sp. nov. (Thysanoptera, Thripidae)

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ABSTRACT: Many species of thrips are known to severely damage crops in the world. Although systematic studies on thrips have been conducted in Taiwan, DNA barcodes, provide important information in species delimitation, have not been established for Taiwanese thrips. Moreover, few studies have been conducted on thrips diversity from mountainous Taiwan, especially with altitudes of >2000 m. The study herein, thrips samples were acquired by picking flowers and using sweep nets from Taiwan island, in which several montane localities are higher than 2000 in elevation. DNA barcodes of thrips species were recorded and analyzed. Twelve thrips were found to be distributed in montane areas, of which *Frankliniella intonsa* (Trybom) was the dominant one, followed by *Thrips palmi* Karny and *Thrips flavus* Schrank. A new species of montane (>2600 m) *Thrips hehuanshanensis* sp. nov., morphologically similar to Taiwanese thrips *Thrips formosanus* Priesner, and two Japanese thrips, *Thrips floreus* Kurosawa and *Thrips shiranesanus* Masumoto & Okajima, is named and described. In addition to the COI barcoding analyses for the new species, measurements of male and female individuals of their body size and seta numbers in the vertex, nota, and abdomen are provided.

KEY WORDS: Insect fauna, montane fauna, new species, *Thrips*, *Thrips formosanus*, *Thrips floreus*, *Thrips shiranesanus*.

INTRODUCTION

Thrips, approximately 1 mm in size mostly, comprises approximately 7000 species in two suborders of Terebrantia and Tubulifera (Mound, 2013; ThripsWiki, 2025). Many thrips are among the most troublesome agricultural pests, and they cause damage through direct feeding or *Orthotospovirus* transmission (Mound, 1996). The genus *Thrips* L. composed of approximately 300 species is the largest genus in Thysanoptera (Mound and Ng, 2009; Mound, 2010; Karadjova and Krumov, 2015; Mound *et al.*, 2022). Identification keys for approximately 94 *Thrips* species distributed in Oriental Regions, including Australia, China, Japan, and Southeastern Asia, are available (Palmer, 1992; Mound and Azidah, 2009; Masumoto and Okajima, 2013; Mound *et al.*, 2022). In Taiwan, 47 genera with 125 terebrantian species were found, including 18 *Thrips* species (Wang, 2002, 2016) although taxonomic studies have been conducted on terebrantian thrips, few field surveys of thrip fauna have been conducted from the montane regions.

Taiwan's mountainous landscape was shaped by the continuous collision of the Eurasian and Philippine Sea plates, resulting in over 250 peaks exceeding 3000 m in elevation. Due to the difficulty of access, the entomofauna of montane regions remains poorly studied. In Taiwan Island, the studies on areas of Hehuan Mountain and Xueshan Mountain, both in an elevation of approximately 3100 m, with a dominant phytocoenosis of

Yushan bamboo (*Yushania niitakayamensis* (Hayata) Keng f, shown the dominant families of Hexapod (Lin *et al.*, 2006; Hua *et al.*, 2023). In an alpine survey at an elevation higher than 3600 m, the maximum numbers of the dominant insects of psyllid (*Cacopsylla strauvaesia* Yang) and aphid (*Ericolophium itoe* (Takahashi)) were mostly could be found in the summer season (Yeh *et al.*, 2012). The mountain-top isolated effect on alpine ground beetles distributing higher than 3000 m has also been elucidated (Weng *et al.*, 2016a,b). For plant biome, a survey for 55 flowering phenology have shown that entomophilous plants were flowering more in summer season, especially in July, along the trail of Xue Mountain in elevation of 2500 m to 3886 m (Wu *et al.*, 2013).

In this study, 12 thrip species from montane areas in Taiwan were collected. The commonly found thrips in these areas are *Frankliniella intonsa* (Trybom), *Thrips palmi* Karny, and *Thrips flavus* Schrank. Moreover, a new species, *Thrips hehuanshanensis* sp. nov. distribution in elevation up to 3100 m is described herein. This new species could only be found at altitudes of >2600 m and is distributed in several mountain ranges including Yushan Range and Hehuanshan Range; and is morphologically similar to *Thrips formosanus* Priesner and two Japanese species, *Thrips floreus* Kurosawa and *Thrips shiranesanus* Masumoto & Okajima. We measured the body size and setae number of this new species, and its cytochrome c oxidase subunit I (COI) barcode sequences were analyzed to identify its candidate cryptic species.

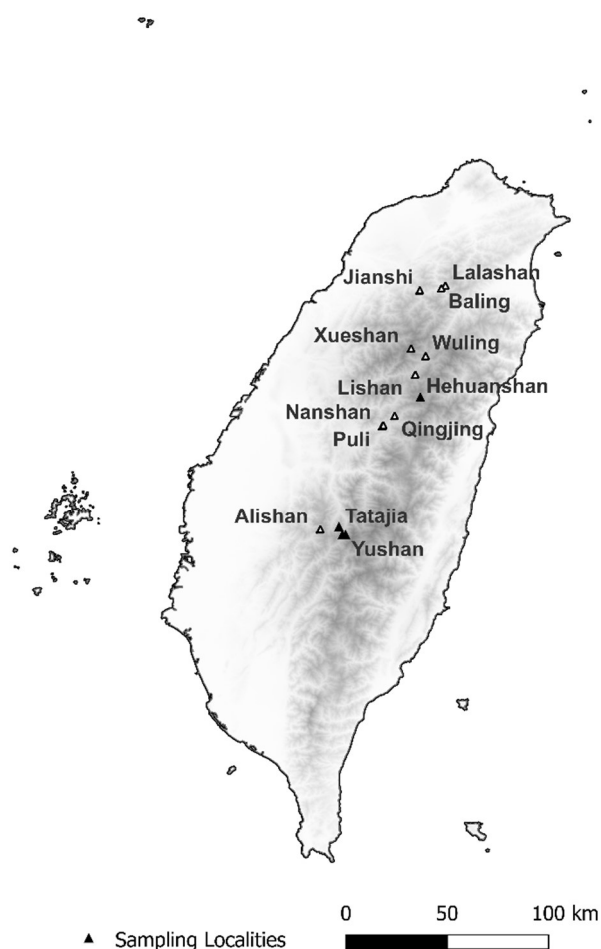


Fig. 1. Sampling localities of thrips from montane Taiwan. Empty triangles are described thrips species and solid triangles are new species.

MATERIALS AND METHODS

Sample collection

Thrips specimens were collected from flowers and by using sweep nets on herbs or shrubs in mountainous areas across Taiwan, primarily at altitudes above 1500 m. The sampling localities map was made by QGIS 3.42.0 (QGIS.org) (Fig. 1 and Table 1). The samples were collected in plastic bags, and thrips were individually picked in the laboratory.

The collected specimens were identified as morphospecies, preserved in 95% alcohol, and stored at -20°C . Individual thrips of each morphospecies were first used for DNA extraction and then were mounted into Canada Balsam DC (Panreac Química SLU, Castellar del Vallès, Barcelona, Spain) for observation under a microscope. The morphological characteristics were examined under a microscope based on taxonomic characteristics (Mound and Kibby, 1998; Wang, 2002, 2007; Masumoto and Okajima, 2013; Tyagi and Kumar,

2015). These mount specimen slides and DNA extraction slides are stored at the Insect Museum, Department of Entomology, National Chung Hsing University, Taiwan.

Morphological measurements

The morphological characteristics of the specimens were analyzed under an EX20 biological microscope (Ningbo Sunny Instruments, Zhejiang, China) fitted with a Canon EOS800D camera (Canon, Tokyo, Japan). The characteristics were further examined and measured using Microsight 4.1.2 (Q-Optics, Texas, USA). The separately focused images were then stacked using Helicon focus 7 (HeliconSoft, Kharkiv, Ukraine).

DNA extraction, amplification, and sequencing

DNA extraction of individual thrips was performed using the QuickExtract DNA Extraction solution 1.0 (Epicentre Illumina, WI, USA). Each specimen was immersed in 50 μL of DNA extraction solution. After vigorous shaking for 15–20 s, the samples were incubated at 65°C for 10 min, followed by an additional 15 s of shaking. Subsequently, the reaction mixture was incubated at 98°C for 2 min and then stored at -20°C . Primer pairs used for amplification of COI sequences were LCO1490 and HCO2198, also used by (Dickey *et al.*, 2015), and those of Thrips-COI 5U (5'CWAATCAYAARGAYATTGG3') and Thrips-COI 1D (5'GGRTGWCCAAAAAATCAAAA3') were designed in this study.

The PCR assay was performed on a 25 μL sample containing 0.5 μL of each primer (10 mM), 0.2 μL of each dNTP (25 mM), 2.5 μL of $10\times$ Taq buffer, 0.5 μL of Super Taq polymerase (5 U/ μL), and 1 μL of DNA template. PCR programming conditions were as follows: denaturation at 95°C for 2 min, followed by 35 cycles of 95°C for 40 s, 45°C for 70 s, and 72°C for 40 s, with a final extension at 72°C for 7 min. The amplified product was stored at 4°C .

The PCR product was subjected to 100-V agarose gel electrophoresis with 1% agarose. The amplified product was either purified directly using a PCR purification kit (Qiagen, Hilden, German) or excised and extracted after resolution on agarose gel using the Qiaquick gel extraction kit (Qiagen, Hilden, German). The resulting DNA product was sequenced in both directions by using BigDye Terminator V3.1 Cycle Sequencing Kit and an ABI 3730XL sequencer (Applied Biosystems, CA, USA).

Molecular analyses

COI sequences of montane thrips in this study, two *F. intonsa* and 116 sequences of 26 *Thrips* species downloaded from GenBank were analyzed (Table S1). The sequences of 29 *Thrips* species and one *Frankliniella* species were assembled and aligned using BioEdit (Hall, 1999) and then verified manually. The proportional variations within and among the thrip species were estimated with IQ-TREE version 1.6.12 (Nguyen *et al.*,

**Table 1.** Collecting information of thrips samples from montane Taiwan.

Location (GPS)	Elevation	Host plant	Thrips species	Date
Yushan				
(23.4734, 120.9072)	2700 m	<i>Thalictrum urbaini</i>	<i>Thrips hehuanshanensis</i> sp.nov.	20 Jul 2021
(23.4724, 120.9217)	3100 m	<i>Reynoutria japonica</i>	<i>Thrips hehuanshanensis</i> sp.nov.	
Lalashan	1200 m	<i>Bidens pilosa</i> L.	<i>Thrips palmi</i> Karny	12 Apr 2018
(24.6904, 121.4058)		<i>Rosa rugosa</i> Thunb	<i>Thrips flavus</i> Schrank	12 Apr 2018
			<i>Thrips palmi</i> Karny	
		<i>Wisteria sinensis</i> (Sims) DC.	<i>Taeniothrips</i> sp.	
			<i>Thrips hawaiiensis</i> Morgan	12 Apr 2018
			<i>Thrips palmi</i> Karny	
Baling, Taoyuan	650 m	<i>Bidens pilosa</i> L.	<i>Frankliniella cephalica</i> Crawford	12 Apr 2018
(24.6784, 121.3863)			<i>Thrips hawaiiensis</i> Morgan	
			<i>Thrips palmi</i> Karny	
Lishan, Taichung	1900 m	<i>Hypochaeris radicata</i> L.	<i>Frankliniella intonsa</i> Trybom	29 Jun 2013
(24.2600, 121.2600)			<i>Thrips palmi</i> Karny	
			Tubulifera	
		<i>Rosa rugosa</i> Thunb	<i>Frankliniella occidentalis</i> Pergande	
		<i>Trifolium pratense</i> L.	<i>Frankliniella intonsa</i> Trybom	
			Tubulifera	
Wuling Farm, Taichung	2200 m	<i>Chrysanthemum morifolium</i> Ramat	<i>Thrips palmi</i> Karny	29 Jun 2013
(24.3500, 121.3100)			Tubulifera	
		<i>Rosa rugosa</i> Thunb	<i>Frankliniella intonsa</i> Trybom	
			<i>Thrips palmi</i> Karny	
		<i>Trifolium pratense</i> L.	<i>Frankliniella intonsa</i> Trybom	
			Tubulifera	
Qingjing Farm, Nantou Co.	1800 m	<i>Hibiscus rosa-sinensis</i> L.	<i>Frankliniella occidentalis</i> Pergande	29 Jun 2013
(24.0600, 121.1600)			<i>Thrips palmi</i> Karny	
Puli	520 m	<i>Ageratum houstonianum</i> Mill.	<i>Microcephalothrips abdominalis</i> Crawford	11 Jul 2013
(24.0100, 121.1000)		<i>Bidens pilosa</i> L.	<i>Frankliniella cephalica</i> Crawford	
			<i>Frankliniella intonsa</i> Trybom	
		<i>Celosia argentea</i> Linn.	<i>Frankliniella intonsa</i> Trybom	
		<i>Luffa aegyptiaca</i> P. Mill.	<i>Frankliniella intonsa</i> Trybom	
		<i>Rosa rugosa</i> Thunb	<i>Frankliniella intonsa</i> Trybom	
Alishan, Chiayi	2100 m	*	<i>Thrips palmi</i> Karny	9 Feb 2012
(23.5063, 120.8000)				
Hehuanshan	3100 m	Flower	<i>Thrips hehuanshanensis</i> sp.nov.	24 Jul 2011
(23.5100, 120.8900)		Flower	<i>Thrips flavus</i> Schrank	
Nanshan, Puli, Nantou Co.	700 m	<i>Bidens pilosa</i> L.	<i>Frankliniella cephalica</i> Crawford	24 Jul 2011
(24.0150, 121.1051)				
Xueshan	3600 m	*	<i>Frankliniella occidentalis</i> Pergande	3 Aug. 2011
(24.3862, 121.2395)		*	<i>Taeniothrips</i> sp.	
		*	<i>Thrips coloratus</i> Schrank	
		*	<i>Thrips flavus</i> Schrank	
		*	<i>Thrips hawaiiensis</i> Morgan	
Tatajia, Nantou Co.	2600 m	*	<i>Thrips flavus</i> Schrank	18 Aug 2011
(23.5100, 120.8900)		*	<i>Thrips hehuanshanensis</i> sp.nov.	
Jianshi, Hsinchu	2000 m	Fern	<i>Thrips formosanus</i> Priesner	16 Oct 2009
(24.6676483, 121.281918)		Weeds	<i>Thrips formosanus</i> Priesner	17 Oct 2009

*Collection via sweeping net

2015). A phylogenetic inference based on the maximum likelihood by model of substitution GTR+F+I+G4 substitution was established in IQ-TREE with 1000 bootstrap replications, phylogenetic trees were viewed and edited in ITOL (Letunic and Bork, 2024). Genetic divergences among the 30 thrips species and within species were analyzed on the basis of the COI gene using MEGA

11 by using the p-distance method (Tamura *et al.*, 2021).

RESULTS

Thrips fauna in montane Taiwan

In addition to Tubulifera and *Taeniothrips* individuals, a total of 540 individuals across 12 thrips species were

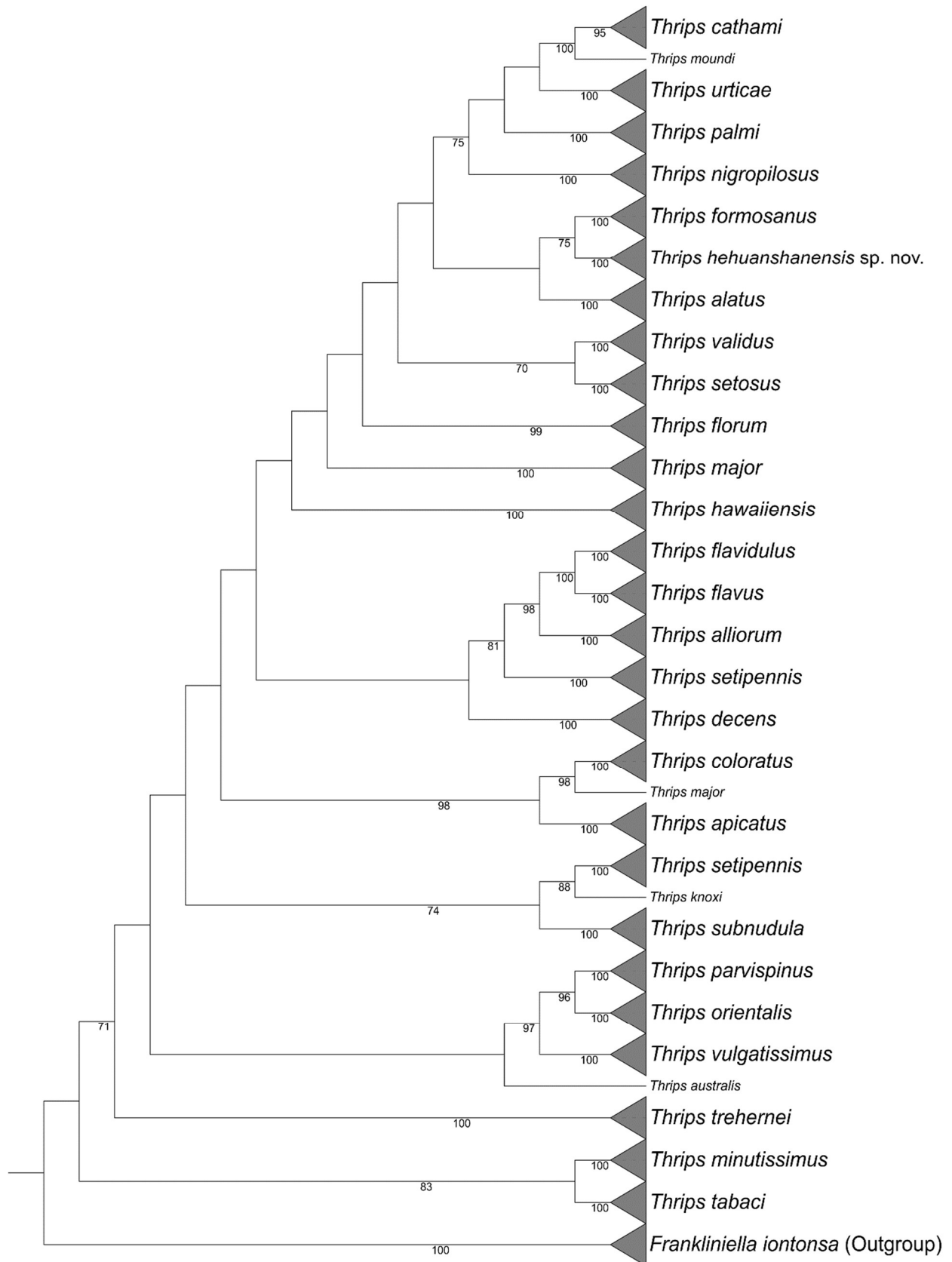


Fig. 2. Phylogenetic clusters of *Thrips* species based on COI sequences obtained using maximum likelihood analysis.



acquired. The most commonly distributed thrips in the studied mountain areas were *F. intonsa*, *Frankliniella cephalica* (Crawford), *T. palmi*, *T. flavus*, *Thrips hawaiiensis* (Morgan), and *Thrips coloratus* Schmutz (Table 1). *Frankliniella intonsa* was found in Puli, Wuling, and Lishan at altitude up to 2200 m and in several types of flowers. *Frankliniella cephalica* species was found in flowers of *Bidens pilosa* and was distributed at altitudes of <1000 m in localities of Baling, Puli, and Nanshan. *Thrips palmi* was most frequently found in most montane areas with an altitude of approximately 2000 m, although it was also distributed at an altitude of 650 m. *Thrips flavus* was found in the montane Tatajia and Lalashan areas and alpine areas, such as Xueshan and Hehuanshan, at an altitude of >3100 m. *Thrips hawaiiensis* was found at altitudes up to 3600 m at Xueshan. *Frankliniella occidentalis* was distributed locally in central Taiwan, including in Lishan, Qingjing, and Xueshan, at an altitude of >1800 m. *Thrips coloratus* is exclusively found in montane areas and was detected in Xueshan at an altitude of 3600 m.

One new *Thrips* species, namely *Thrips hehuanshanensis* sp. n., was found. A total of 28, 18 and 4 individual specimens of the new species were acquired in Mt. Hehuanshan (~3100 m elevation), Tatajia (~2600 m elevation), and Yushan (~3100 m), respectively.

Genetic differentiation of *Thrips hehuanshanensis* sp. nov. from other thrips

A molecular phylogenetic tree analysis based on 160 COI genes of 31 *Thrips* species was conducted (Fig. 2). The sequence divergences among species were mostly between 5% to 22% and within species ranged from 0% to 0.12% (Table S2). Bootstrap values were high for each species (Fig. S1). DNA analysis results revealed that *T. hehuanshanensis* sp. nov. is monophyletic with a large divergence ranging 12.8–17.8% to the other *Thrips* species (Table S2). The COI sequences of new species were deposited in GenBank under accession numbers of (PQ247044–PQ247055).

TAXONOMIC TREATMENT

Thrips hehuanshanensis Boonmee & Yeh, sp. nov.

合歡山薊馬 Fig. 3-5

urn:lsid:zoobank.org:act: A546F2E8-3771-4186-9266-5C4523B5B5CF

Type material: *Holotype*: a female (Individual 1 in Table 2 and Table 3), deposited in Museum of Entomology, Department of Entomology, National Chung Hsing University (NCHU), labeled: TAIWAN, Nantou, Lernai, Hehuanshan, 08 April 2011, Wen-Bin Yeh collector (red label). **Paratypes**: A total of 7 with 3 males and 4 females with the same collection data as the holotype (Table 2).

Description: Female (Figs. 3-5): Entire body brown. **Head and prothorax** brown; ptero-thorax brown with dark



Fig. 3. *Thrips hehuanshanensis* sp. nov., whole body for female. Scale bar is 0.1 mm.

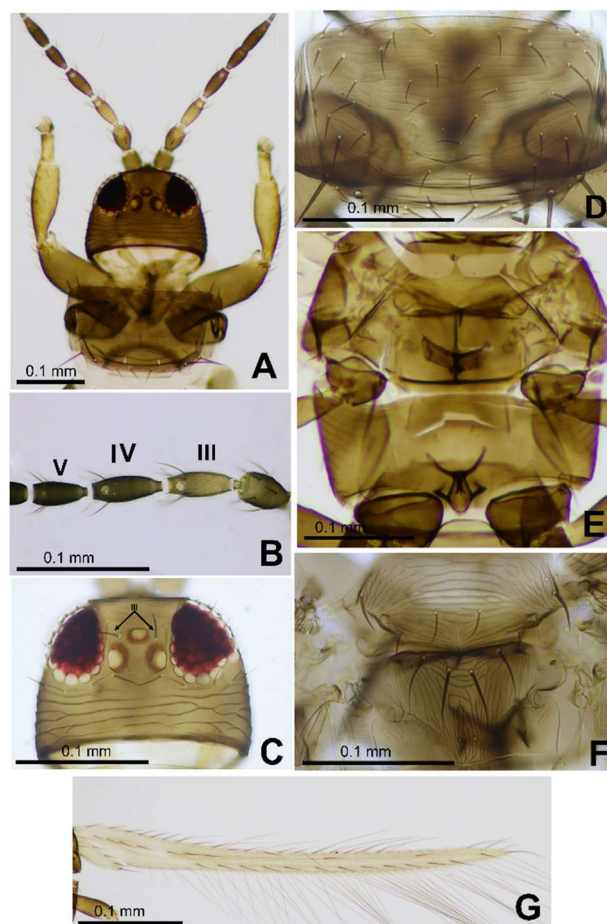


Fig. 4. *Thrips hehuanshanensis* sp. nov., head and thorax, female. **A.** head and pronotum; **B.** antenna, segments III–V are marked; **C.** head, ocellar seta III is marked; **D.** pronotum; **E.** pterothorax, spinula; **F.** mesonotum and metanotum; **G.** forewing. Scale bar is 0.1 mm.



Table 2. Setae number of wing vein and the characteristics in abdominal tergite (T) and sternite (S) II–IX including setae number, campaniform sensillum (CPS), and marginal comb of *Thrips hehuanshanensis* sp. nov.

Individuals Characters		Female					Male		
		1	2	3	4	5	1	2	3
Wing vein									
	Upper	11	11	11	11	11	10	10	10
	Lower	12	12	12	13	12	10	11	13
Abdominal setae, CPS, & Comb									
II	Discal (T)	4	4	4	4	4	4	4	4
	Lateral (T)	8	8	8	8	6	8	8	8
	Posterior (S)	4	4	4	4	4	4	4	4
III	Discal (T)	4	4	4	4	4	4	4	4
	Lateral (T)	6	6	6	6	6	6	6	6
	Posterior (S)	6	6	6	6	6	6	6	6
IV	Discal (T)	4	4	4	4	4	4	4	4
	Lateral (T)	6	6	6	6	6	6	6	6
	Posterior (S)	6	6	6	6	6	6	6	6
V	Discal (T)	4	4	4	4	4	4	4	4
	Lateral (T)	6	6	6	6	6	6	6	6
	Posterior (S)	6	6	6	6	6	6	6	6
VI	Discal (T)	4	4	4	4	4	4	4	4
	Lateral (T)	6	6	6	6	6	4	4	6
	Posterior (S)	6	6	6	6	6	6	6	6
VII	Discal (T)	4	4	4	4	4	4	4	4
	Lateral (T)	6	6	6	6	6	4	6	6
	Posterior (S)	6	6	6	6	6	6	8	8
VIII	Discal (T)	4	4	4	4	4	4	4	4
	Lateral (T)	8	8	8	8	8	8	6	6
	Marginal comb	C*	C*	C*	C*	C*	I*	I*	I*
IX	Discal (T)	6	6	6	6	6	6	6	6
	Lateral (T)	6	6	6	6	6	6	6	6
	Posterior (S)	4	4	4	4	4	-	-	-
	CPS (T)	4	4	4	4	4	4	4	4
X	Discal (T)	4	4	4	4	4	4	4	4
	Lateral (T)	2	2	2	2	2	2	2	2
	Posterior (S)	4	4	4	4	4	-	-	-

brown anteriorly and laterally. **Abdominal tergites** I–IX yellowish brown with brown laterally. Seven **antennal segments**, yellowish brown to dark brown with light antennomere I–III (Fig. 4A,B).

Head (Fig. 4C and Table 2) approximately as long as broad or a slightly shorter, broadly rounded at the front. Dorsal surface tuberculate with a wedge-shape reticulation extending from middle to posterior margin. Three **ocelli**, two posteriolateral ocelli placed close to eyes; ocellar setae III out of ocelli triangle in length similar to ocellar setae II. **Postocular setae** seven pairs, length of pair I similar to ocellar setae III, pair II and IV very short, pair III, V, VI slightly shorter to pair I. **Antennae** seven segments, arising ventrally (Fig. 4A), segments VI–VII closely joined with a complete suture; segment III with pale color than other; segments III–IV with short forked sense cone (Fig. 4B); segments IV–VII dark brown and VII very short.

Thorax

Pronotum rectangular (Fig. 4D and Table 2), length as head but a little wider, dorsal surface with irregular sculpture; epimeral setae well developed; posterior setae 6 pairs, one short pair setae between two pairs of

posteroangular elongate setae, three pairs of posterior middle setae short (Fig. 4A,D). **Mesoacrotergite** strongly constricted medially by a very narrow bridge (Fig. 4E,F); furcae in mesosoma with middle spinula and cure metasoma furca without spinula (Fig. 4E); mesonotum sculptured with longitudinal striae except anteromedially, with one pair of campaniform sensillum (CPS) laterally, one pair setae each in anteriorangle, discal, and posteroangular; metanotum sculptured with longitudinal reticulations with two pairs of setae, one close to anterior margin medially, the other discal closely behind anterior margin, one uncover CPS in the bottom (Fig. 4F). **Forewing** fringe cilia, bulging base without setae; lower lined vein with 12–13 setae and 10 setae in the upper vein in discontinuously with three to four setae on posterior half (Fig. 4G).

Abdomen

Abdominal segments, a slender median longitudinal plate bearing a pair of CPS in tergite III–VII (Figs. 5A,B, and Table 2); **tergite II** with 4 lateral marginal setae; **tergite III–VII** lateral marginal with two setae and one posteroangular setae, pleurotergites without discal setae (Figs. 5A,C); **sternite III–VII** 3 pairs posterior setae (Figs. 5B,D); **tergite VIII** with complete posteriomarginal comb, spiracle out of the microtribia, two pairs of discal setae, one pair of CPS (Fig. 5E), posteroangular with 2 pairs long setae and one weak setae; three pairs of subposterior long setae on **tergite IX** >1.5 times as long as sub-median discal setae (Fig. 5F), two pairs of weak posterior setae and 2 pairs of CPS; **ovispan** slightly reduced in tip (Fig. 5G). The tergite X is approximately as long as its width at the end. The anal setae consist of two pairs, each 1.5 times as long as tergite X, along with two pairs of weak posterior setae.

Male body color brown (Fig. 5H), ventral surface reddish brown. **Abdominal sternite III–VII** pore plate (gland) (Figs. 5H,I); **tergite VIII** posteromarginal comb incomplete and weak (Fig. 5J); **tergite IX** one posteroangular long seta with one weak seta beneath, three pairs setae weak to middle; **tergite X** trapezoid, two pairs long posteroangular setae.

Measurements: Female (Table 3); body length 1.3–1.5 mm. Antennal length 0.2–0.30 mm. Head length 0.11–0.13 mm. Pronotum length 0.11–0.13 mm; median width 0.18–0.2 mm; post angular long setae 0.04–0.05 mm, short setae 0.02 mm. Metathoracic length 0.07–0.08 mm, width 0.12–0.14 mm. Mesothoracic length 0.07–0.08 mm. Abdominal tergite length 0.8–0.9 mm, width 0.26–0.32 mm.

Male (Table 3); body length 1–1.2 mm. Antennal length 0.22–0.25 mm. Head length 0.09–0.12 mm. Pronotum length 0.09–0.11 mm; median width 0.17 mm; post angular long setae 0.04–0.05 mm, short setae 0.02 mm. Metathoracic length 0.06 mm, width 0.11 mm. Mesothoracic length 0.06 mm. Abdominal tergite length 0.6–0.7 mm, width 0.21 mm.

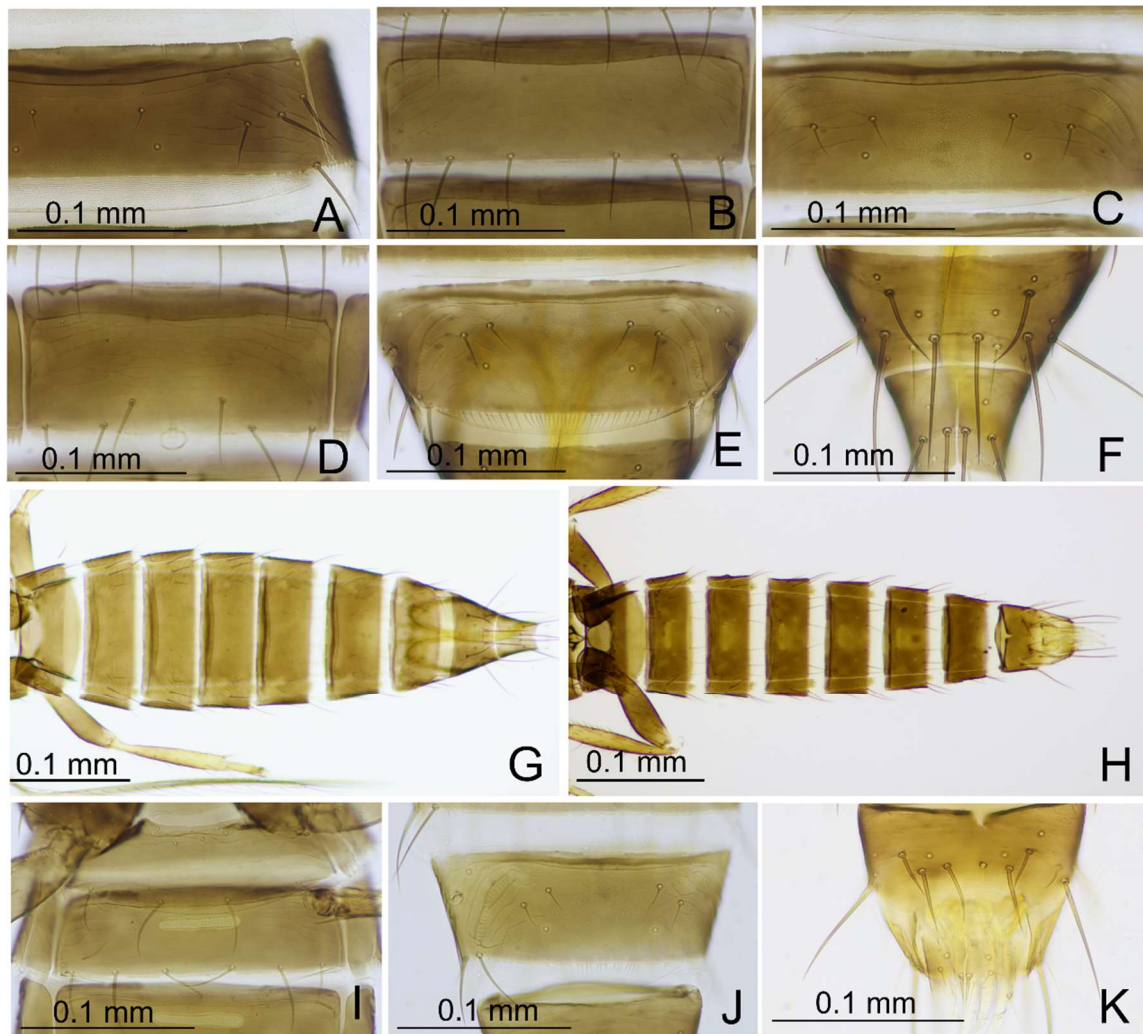


Fig. 5. *Thrips hehuanshanensis* sp. nov., abdomen of female (A–G) and male (H–K). A, B. tergite and sternite IV; C, D. tergite and sternite VII; E. tergite VIII; F. tergite IX–X; G. abdomen of female; H. abdomen of male; I. sternite VII of male; J. tergite VIII of male; K. tergite IX–X of male. Scale bar is 0.1 mm.

Table 3. Measurements of body size and the setae of five females and three males of *Thrips hehuanshanensis* sp. nov.

Individuals Characters	Female (mm)						Male (mm)			
	1	2	3	4	5	Mean $\pm$ SE	1	2	3	Mean $\pm$ SE
Body length	1.484	1.421	1.504	1.541	1.353	1.488 $\pm$ 0.033	1.025	1.039	1.189	1.084 $\pm$ 0.052
Antennae length	0.299	0.267	0.278	0.290	0.264	0.283 $\pm$ 0.007	0.237	0.221	0.252	0.237 $\pm$ 0.009
Head length	0.121	0.131	0.109	0.117	0.112	0.119 $\pm$ 0.004	0.097	0.120	0.122	0.113 $\pm$ 0.008
width	0.172	0.174	0.162	0.162	0.158	0.168 $\pm$ 0.003	0.151	0.141	0.163	0.152 $\pm$ 0.006
Ocelli setae I	-	-	-	-	-	-	-	-	-	-
II	0.023	0.020	0.018	0.019	0.020	0.02 $\pm$ 0.001	0.018	0.014	0.018	0.017 $\pm$ 0.001
III	0.023	0.023	0.025	0.024	0.024	0.024 $\pm$ 0.000	0.018	0.016	0.023	0.019 $\pm$ 0.002
Post ocular setae I	0.022	0.028	0.020	0.018	0.021	0.022 $\pm$ 0.002	0.018	0.019	0.018	0.183 $\pm$ 0.000
II	0.018	0.017	0.018	0.017	0.016	0.018 $\pm$ 0.000	0.018	0.018	0.018	0.018 $\pm$ 0.000
Pronotum length	0.129	0.117	0.129	0.118	0.109	0.123 $\pm$ 0.004	0.113	0.096	0.114	0.108 $\pm$ 0.006
width	0.193	0.200	0.194	0.194	0.181	0.195 $\pm$ 0.003	0.158	0.147	0.173	0.159 $\pm$ 0.007
Pronotum posterior setae I	0.053	0.055	0.049	0.047	0.049	0.051 $\pm$ 0.001	0.053	0.045	0.056	0.051 $\pm$ 0.003
II	0.025	0.021	0.020	0.021	-	0.022 $\pm$ 0.001	0.018	0.018	0.018	0.018 $\pm$ 0.000
Metathoracic length	0.088	0.087	0.082	0.079	0.073	0.084 $\pm$ 0.003	0.063	0.059	0.068	0.063 $\pm$ 0.003
width	0.140	0.132	0.132	0.134	0.119	0.135 $\pm$ 0.03	0.106	0.112	0.124	0.114 $\pm$ 0.005
Mesothoracic length	0.081	0.077	0.076	0.078	0.069	0.078 $\pm$ 0.002	0.067	0.067	0.067	0.067 $\pm$ 0.000
width	0.138	0.131	0.122	0.136	0.126	0.132 $\pm$ 0.003	0.108	0.108	0.126	0.114 $\pm$ 0.006
Abdominal length	0.899	0.881	0.959	0.979	0.837	0.94 $\pm$ 0.033	0.621	0.635	0.772	0.676 $\pm$ 0.048
width	0.329	0.310	0.291	0.299	0.260	0.307 $\pm$ 0.011	0.205	0.188	0.236	0.210 $\pm$ 0.014



Distribution: Taiwan: Mt. Hehuanshan, Taroko National Park, ca. 3100 m elevation, 23°51'00"N, 120°89'00"E; Tatajia, Nantou County, ca. 2600 m, 23°51'00"N, 120°89'00"E; Yushan (Jade Mountain), Xinyi Township, Nantou County, ca. 1400 m (23°47'34"N, 120°90'72"E) host plant *Thalictrum urbaini* and ca. 3100 m (23°47'24"N, 120°92'17"E) host plant *Reynoutria japonica*.

Etymology: The newly identified species is named after its type locality, Mt. Hehuanshan, situated in elevation of 3100 m.

Remarks: This species can be found at altitudes of >2600 m. The new species is morphologically similar to Taiwanese thrips *T. formosanus* and two Japanese species, namely *T. floreus* and *T. shiranesanus* (Masumoto and Okajima 2013). They share following morphological characters in *Thrips formosanus* group (Tyagi and Kumar, 2015): body brown, antennae composed of 7 segments, metanotum exhibiting longitudinal reticulate sculpture centrally, with the median pair of metanotal setae positioned significantly posterior to the anterior margin, forewing's first vein featuring 3 setae on its distal half, abdominal sternites III–VII and laterotergites devoid of discal setae, tergite VIII characterized by a prominent posteromarginal comb of fine and elongated microtrichia. However, the new species could be distinguished based on their uniformly brown forewings that are slightly pale at the base, weak brown antennal segment III, ocellar seta pair III clearly outside the ocellar triangle, and the anterior discal seta in tergite VIII closer than the second one. By contrast, in the two Japanese species mentioned above, one-third of the forewings is pale, the antennal segment is uniformly brown, ocellar seta III is on the anterior margin of the ocellar triangle, and the anterior discal seta in tergite VIII is more distant than the second one. In *T. formosanus*, postocular I is shorter than ocellar III contrast to the new species, they are similar lengths. The mesonotum of the new species is sculptured with longitudinal striae contrast to *T. formosanus*, which features a mesonotum with dense striae.

DISCUSSION

Thrips are known to severely damage crops in the world. Several symposiums and workshops on the control and management of thrips have been conducted in Taiwan (Chang, 2012). Although taxonomic studies on thrips have been conducted (Wang, 2002, 2007, 2016), thrip fauna surveys were limited. In the present study, 12 montane thrips species were studied, including one new species. Three species from genus *Frankliniella* and six species from genus *Thrips* were analyzed, of which *F. intonsa* and *T. palmi* were the primary ones. One species from genus *Microcephalothrips* the other one each from genus *Taeniothrips* and suborder Tubulifera, respectively. *Frankliniella occidentalis*, restricted to local montane areas (Wang, 2012), is distributed in montane

areas in elevation higher than 1800 m. *Thrips palmi* has been widely distributed in tropical and subtropical regions, including Southeast Asia, the Pacific Islands, the Caribbean Islands, and South America in 1970. It became a serious pest of vegetable crops in Japan in 1978 (Murai, 2002). However, *T. palmi* was commonly found in montane areas up to 2200 m in elevation.

Thrips hehuanhanensis sp. nov. is distinguishable by its DNA and morphological characters and is found at altitudes above 2600 m. In this study, another possible new montane, *Taeniothrips* species, distributed at an altitude of 3100 m in Xueshan was observed; however, one individual sample is insufficient to describe this species.

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