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APPENDICES

APPENDIX A

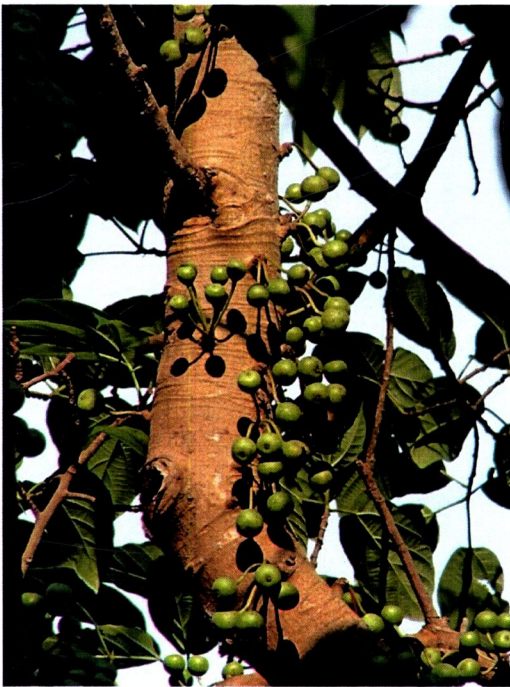
**THE ILLUSTRATIONS OF THE SEVEN SELECTED DIOECIOUS *FICUS*
SPECIES**



Ficus auriculata Lour.



Ficus oligodon Miquel



Ficus variegata Blume



Ficus hispida L.f.



Ficus semicordata Buch.-Ham. ex Sm.



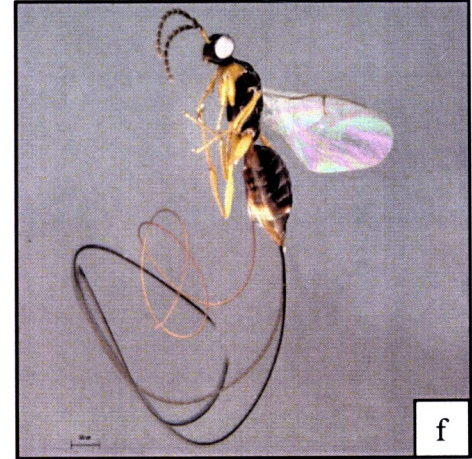
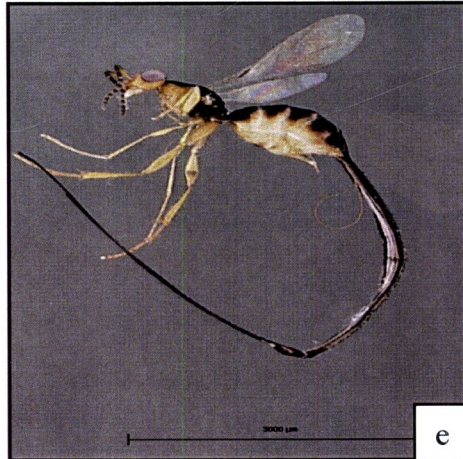
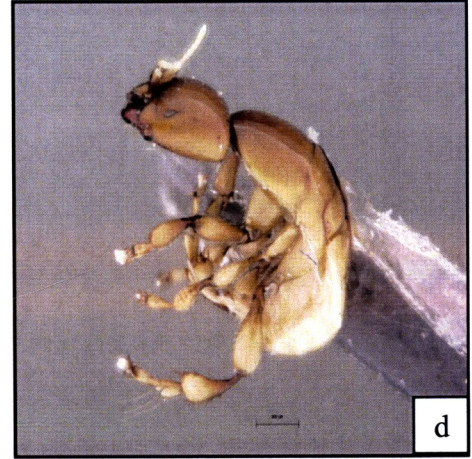
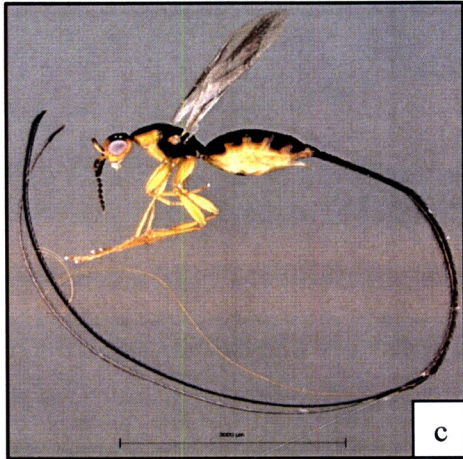
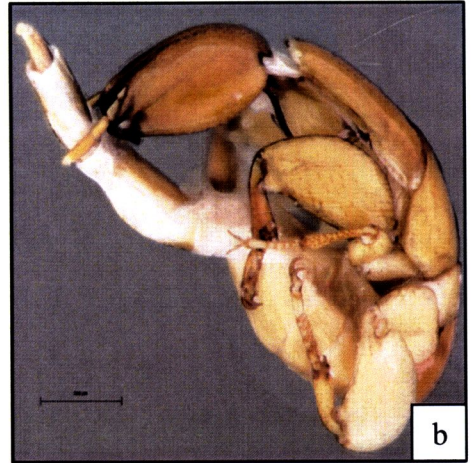
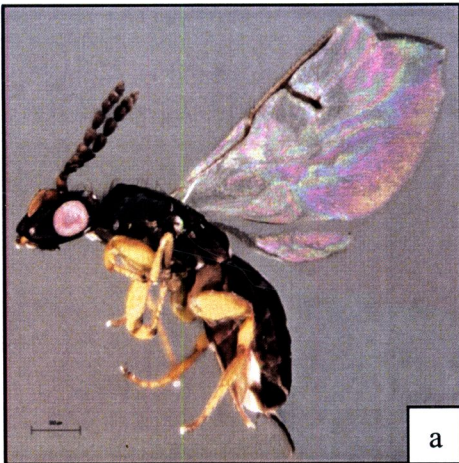
Ficus fulva Reinw. ex Blume



Ficus triloba Buch.-Ham. ex Voigt

APPENDIX B

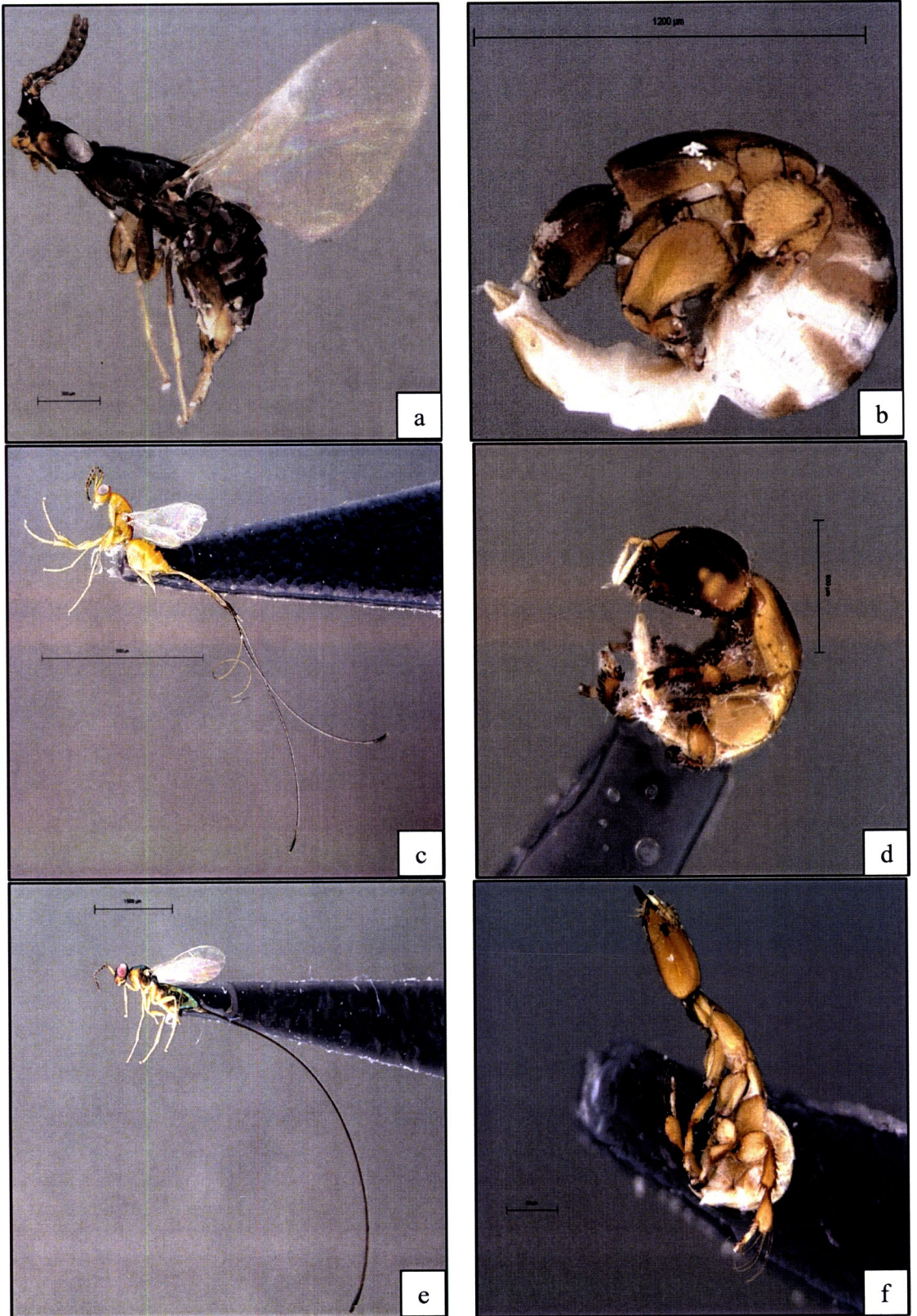
**THE ILLUSTRATIONS OF THE FIG WASPS DEVELOPING IN FIGS OF
FICUS AURICULATA IN DOI SUTHEP-PUI NATIONAL PARK,
NORTHERN, THAILAND**



(a) female *Ceratosolen emarginatus*, (b) male *Ceratosolen emarginatus*, (c) female *Philotrypesis longicauda*, (d) male *Philotrypesis longicauda*, (e) *Philotrypesis* sp. and (f) *Platyneura* sp.

APPENDIX C

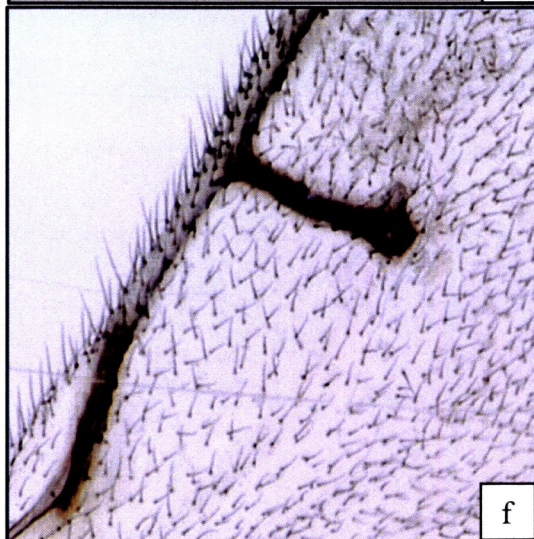
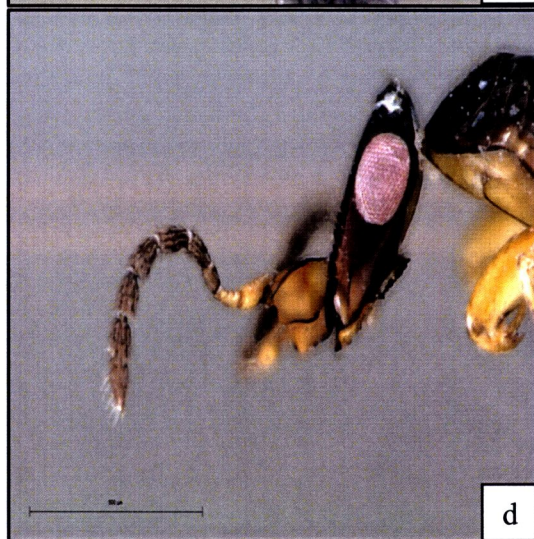
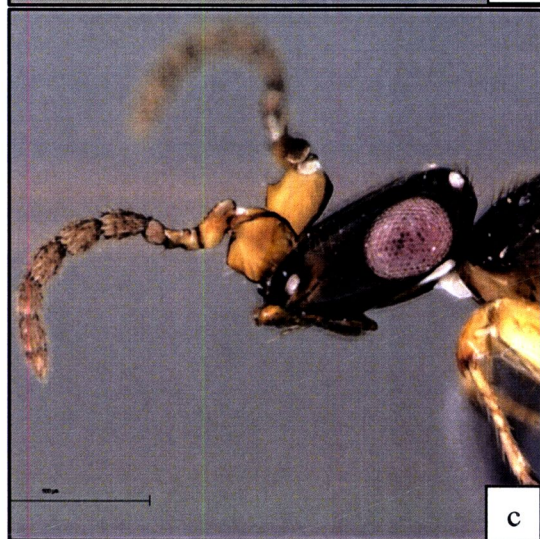
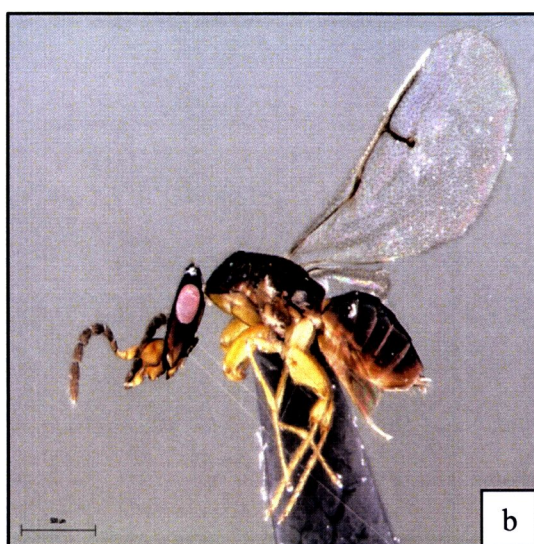
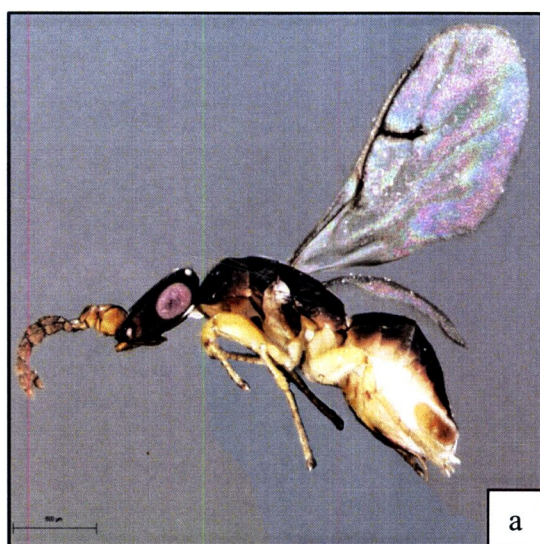
**THE ILLUSTRATIONS OF THE FIG WASPS DEVELOPING IN FIGS OF
FICUS FULVA IN DOI SUTHEP-PUI NATIONAL PARK,
NORTHERN, THAILAND**

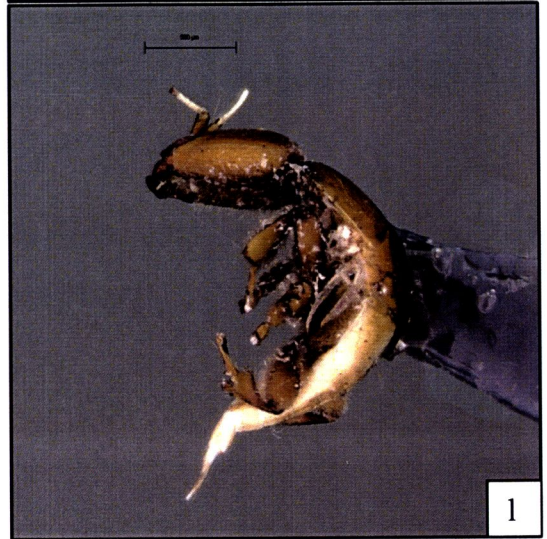
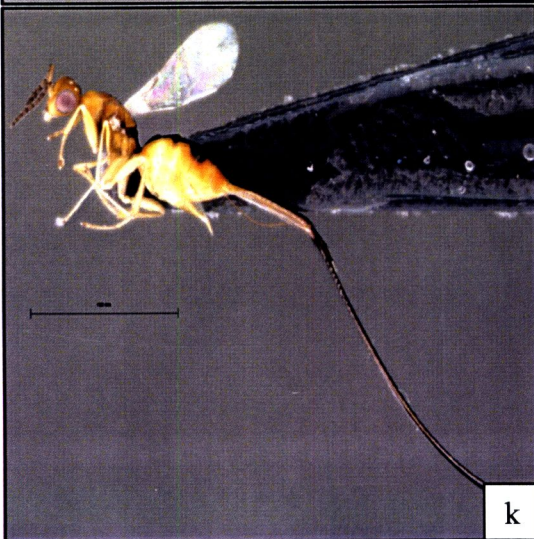
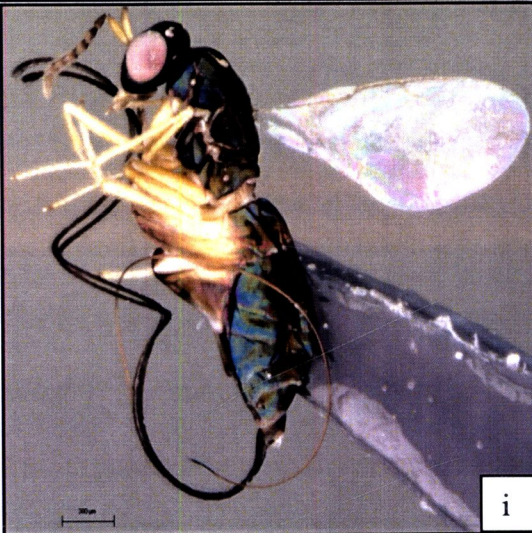
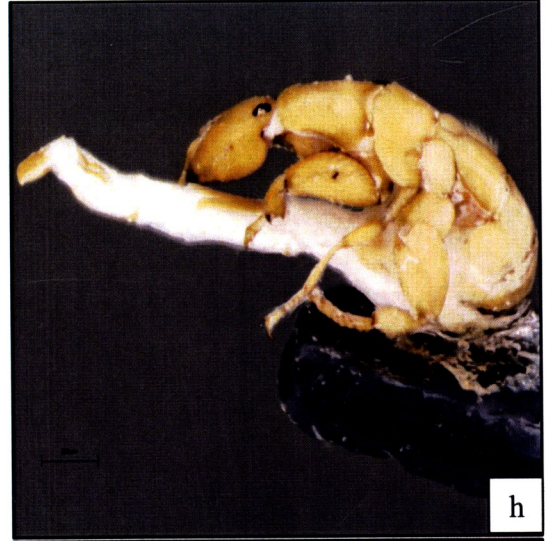


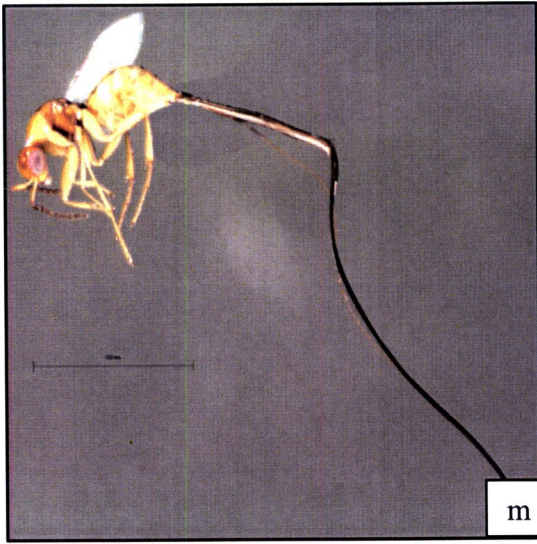
(a) female *Valisia compacta*, (b) male *Valisia compacta*, (c) female *Philotrypesis* sp., (d) male *Philotrypesis* sp., (e) female *Sycoscapter* sp. and (f) male *Sycoscapter* sp.

APPENDIX D

**THE ILLUSTRATIONS OF THE FIG WASPS DEVELOPING IN FIGS OF
FICUS HISPIDA IN DOI SUTHEP-PUI NATIONAL PARK,
NORTHERN, THAILAND**



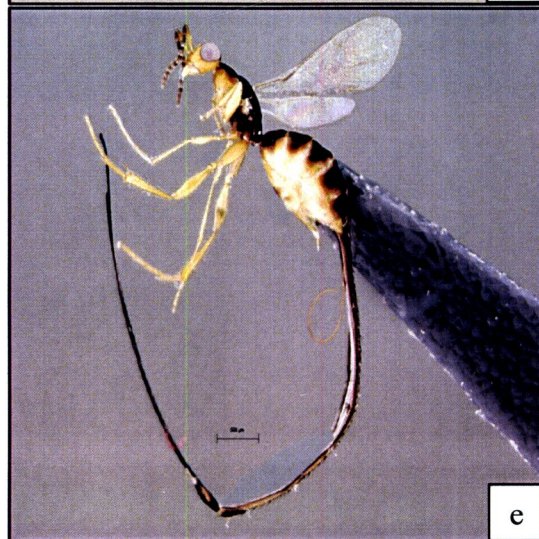
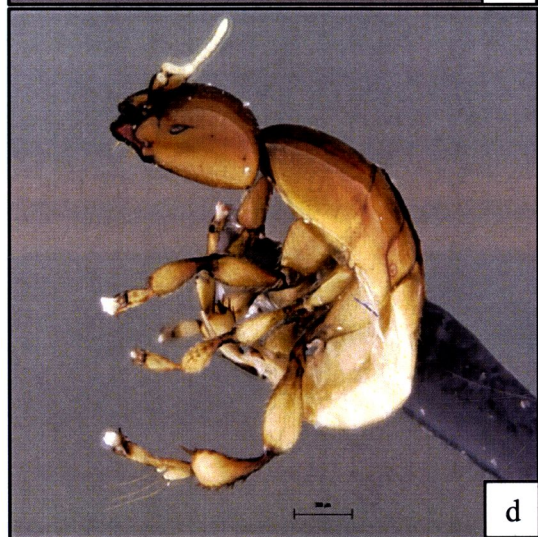
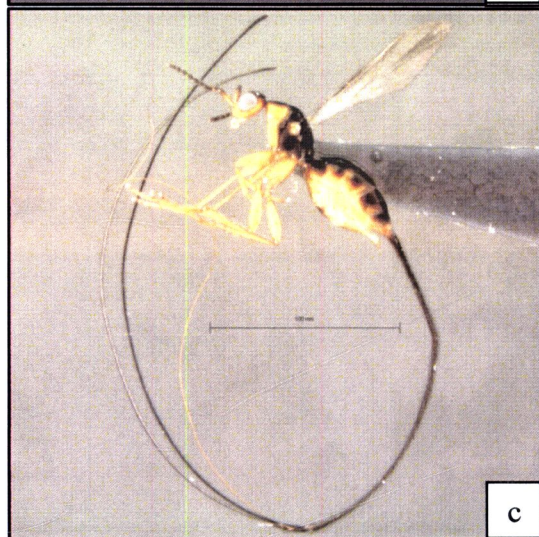
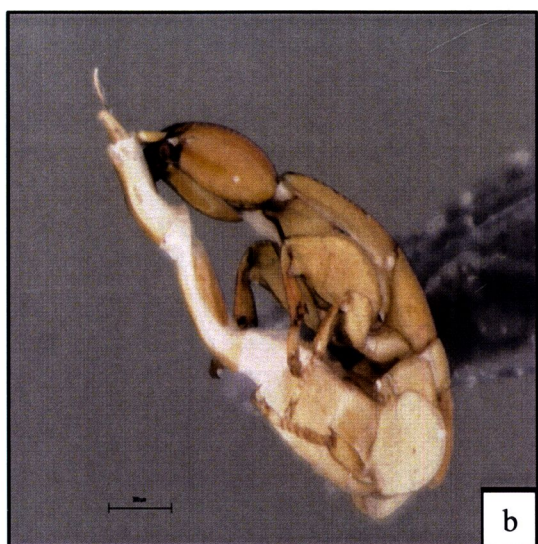
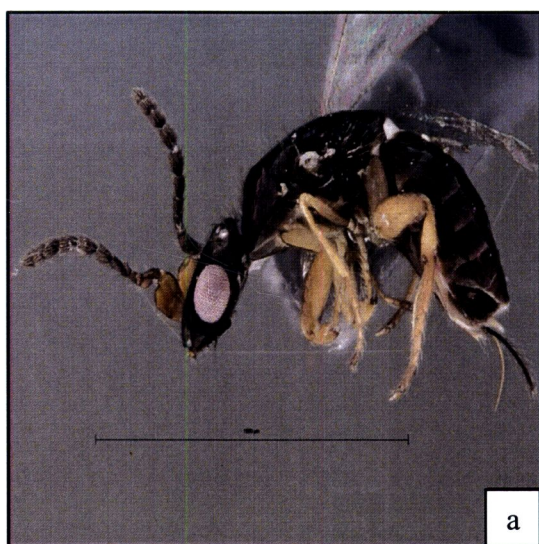


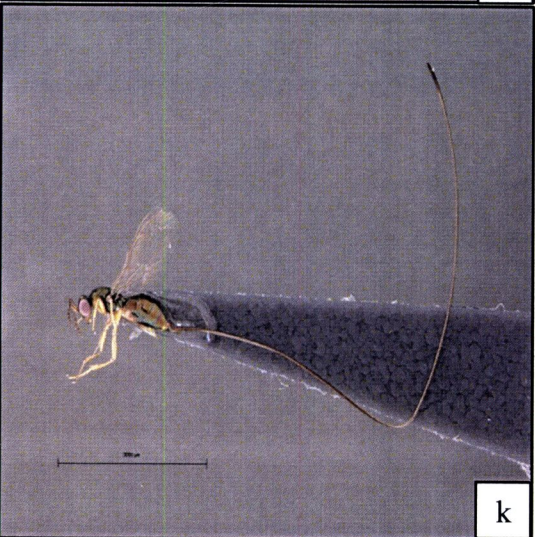
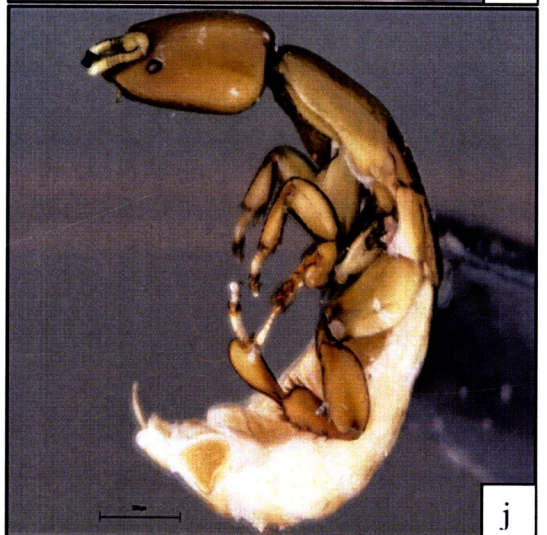
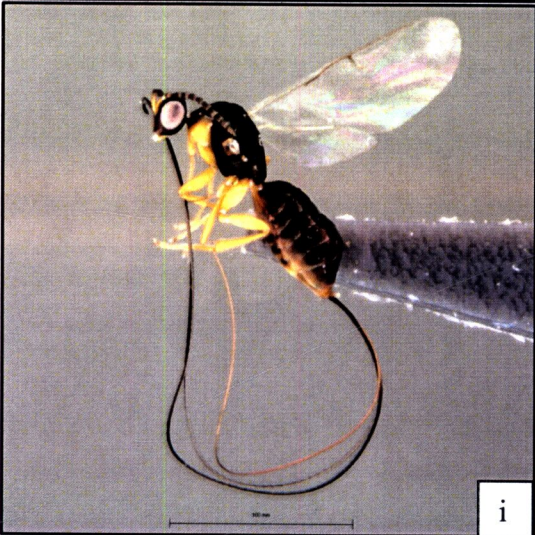
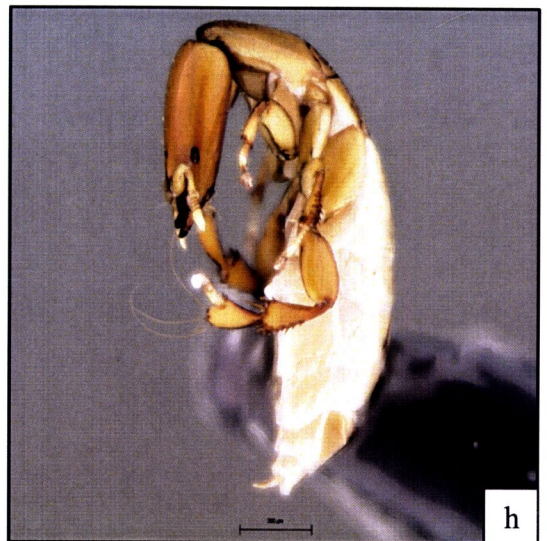
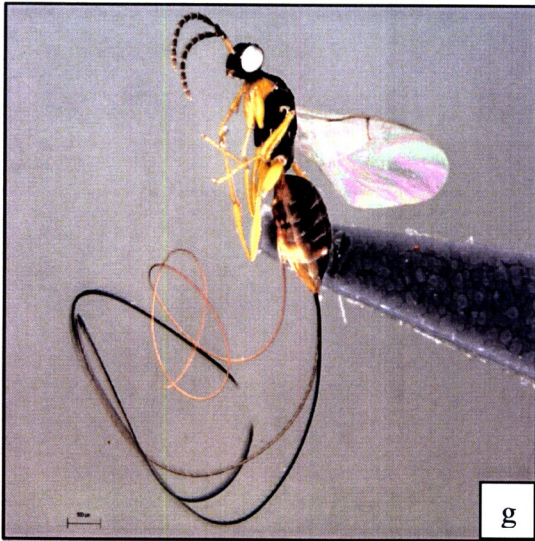


(a) female *Ceratosolen solmsi marchali*, (b) female *Ceratosolen solmsi*, (c) head of *Ceratosolen solmsi marchali*, (d) head of *Ceratosolen solmsi*, (e) venation of *Ceratosolen solmsi marchali*, (f) venation of *Ceratosolen solmsi*, (g) male *Ceratosolen solmsi marchali*, (h) male *Ceratosolen solmsi*, (i) female *Apocrypta bakeri*, (j) male *Apocrypta bakeri*, (k) female *Philotrypesis pilosa*, (l) male *Philotrypesis pilosa*, (m) female *Philotrypesis* sp. and (n) male *Philotrypesis* sp.

APPENDIX E

**THE ILLUSTRATIONS OF THE FIG WASPS DEVELOPING IN FIGS OF
FICUS OLIGODON IN DOI SUTHEP-PUI NATIONAL PARK,
NORTHERN, THAILAND**



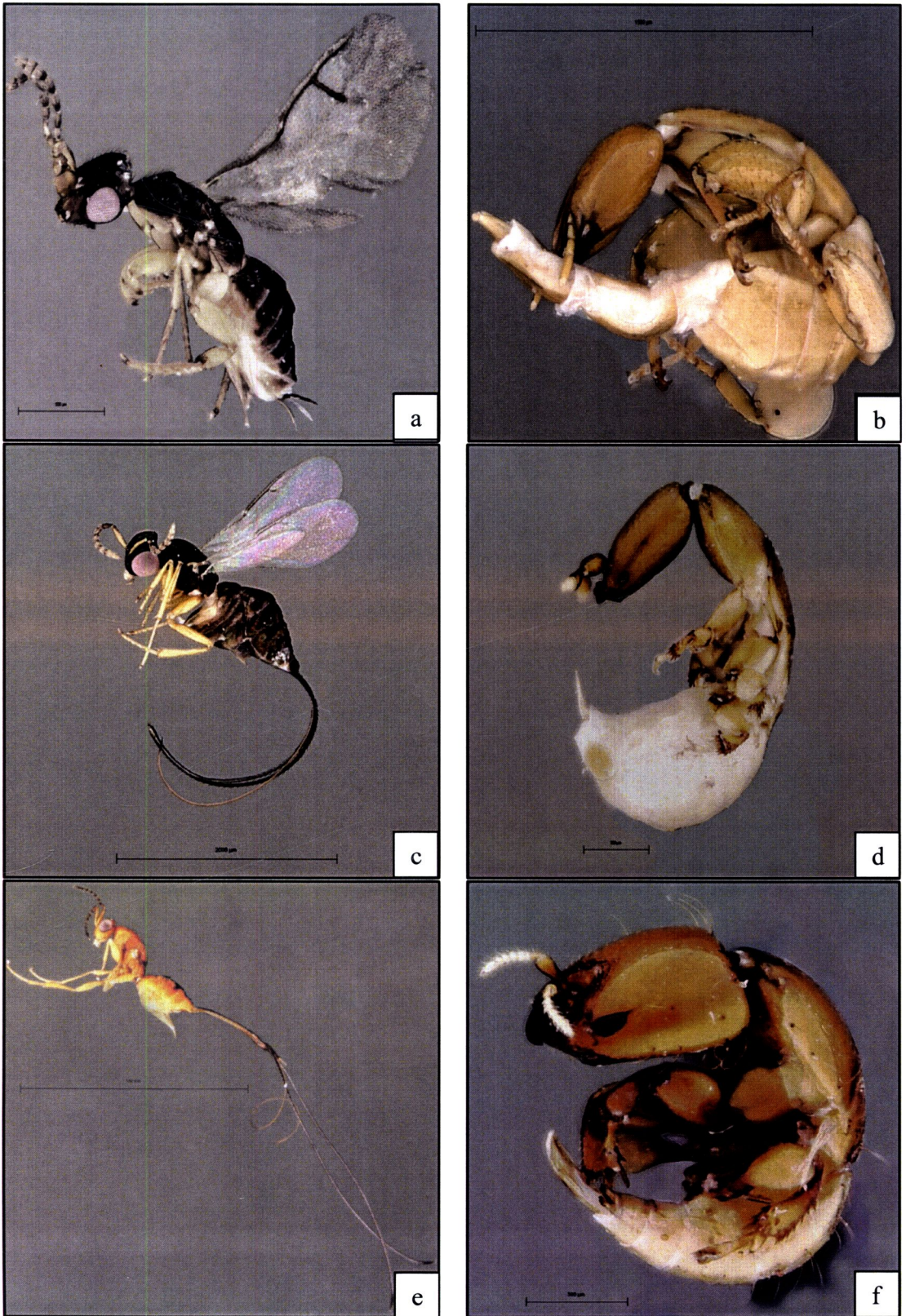




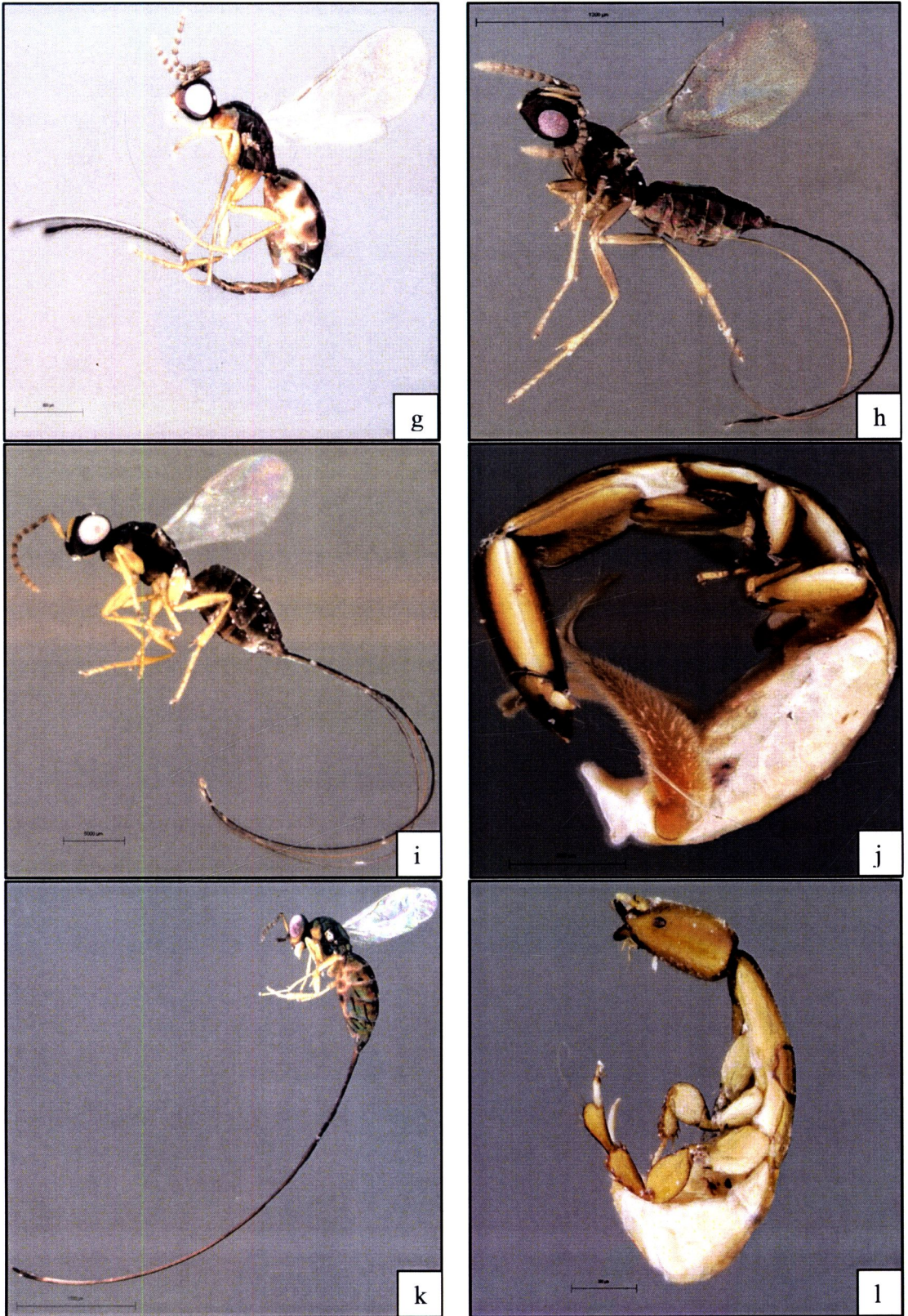
(a) female *Ceratosolen emarginatus*, (b) male *Ceratosolen emarginatus*, (c) female *Philotrypesis longicaudata*, (d) male *Philotrypesis longicaudata*, (e) female *Philotrypesis* sp1, (f) male *Philotrypesis* sp1, (g) female *Platyneura* sp1, (h) male *Platyneura* sp1, (i) female *Platyneura* sp2, (j) male *Platyneura* sp2, (k) female *Sycoscapter roxberghi*, (l) male *Sycoscapter roxberghi* and (m) *Platyneura* which oviposited on the female figs of *F. oligodon* and produced viable offspring.

APPENDIX F

**THE ILLUSTRATIONS OF THE FIG WASPS DEVELOPING IN FIGS OF
FICUS SEMICORDATA IN DOI SUTHEP-PUI NATIONAL PARK,
NORTHERN, THAILAND**



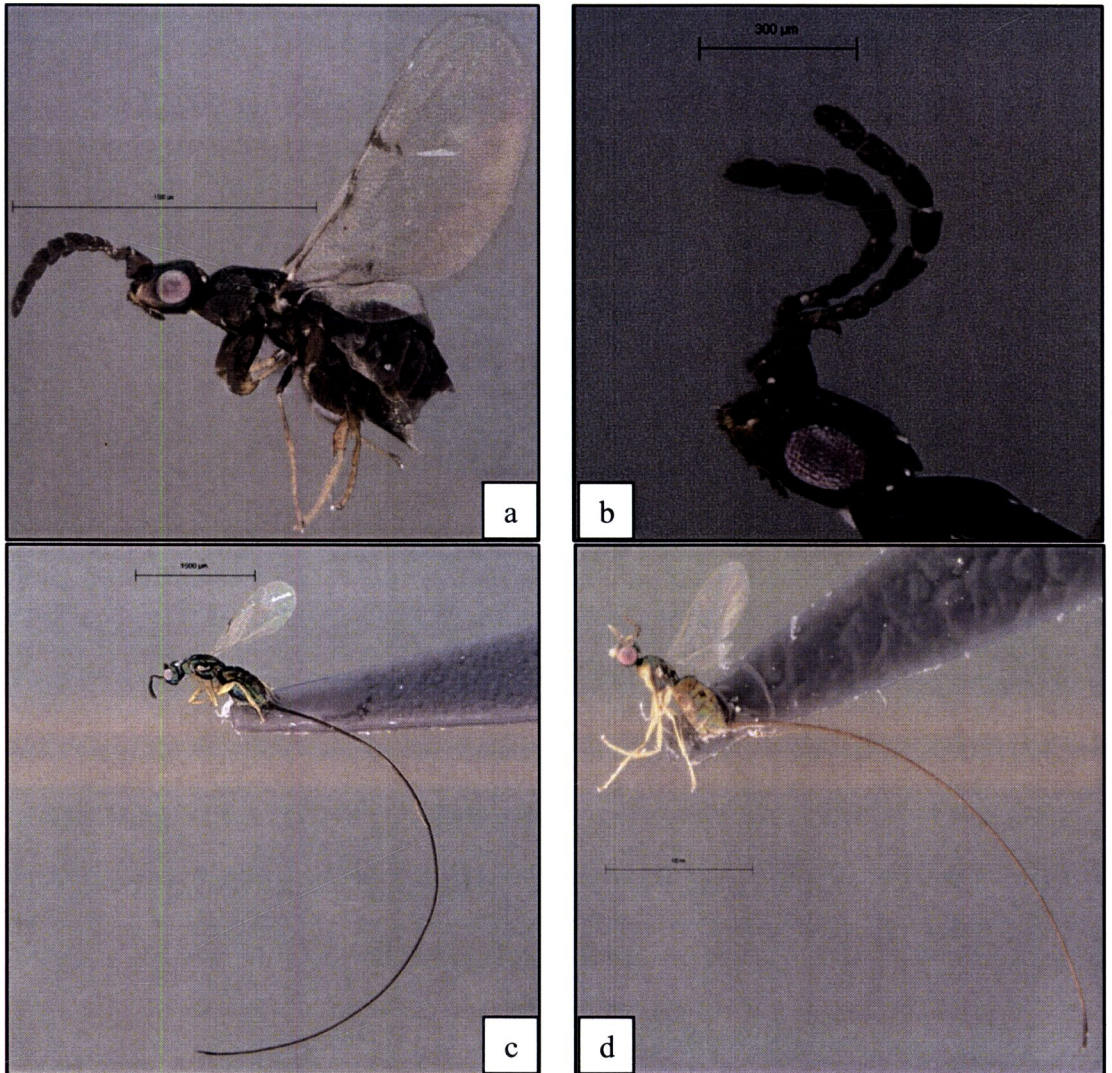
(a) female *Ceratosolen gravelyi*, (b) male *Ceratosolen gravelyi*, (c) female *Apocrypta* sp., (d) male *Apocrypta* sp., (e) female *Philotrypesis dunia*, (f) male *Philotrypesis dunia*.



(g) *Philotrypesis* sp1, (h) *Platyneura* sp1, (i) female *Platyneura cunia*, (j) male *Platyneura cunia*, (k) female *Sycoscapter trifemmensis* and (l) male *Sycoscapter trifemmensis*.

APPENDIX G

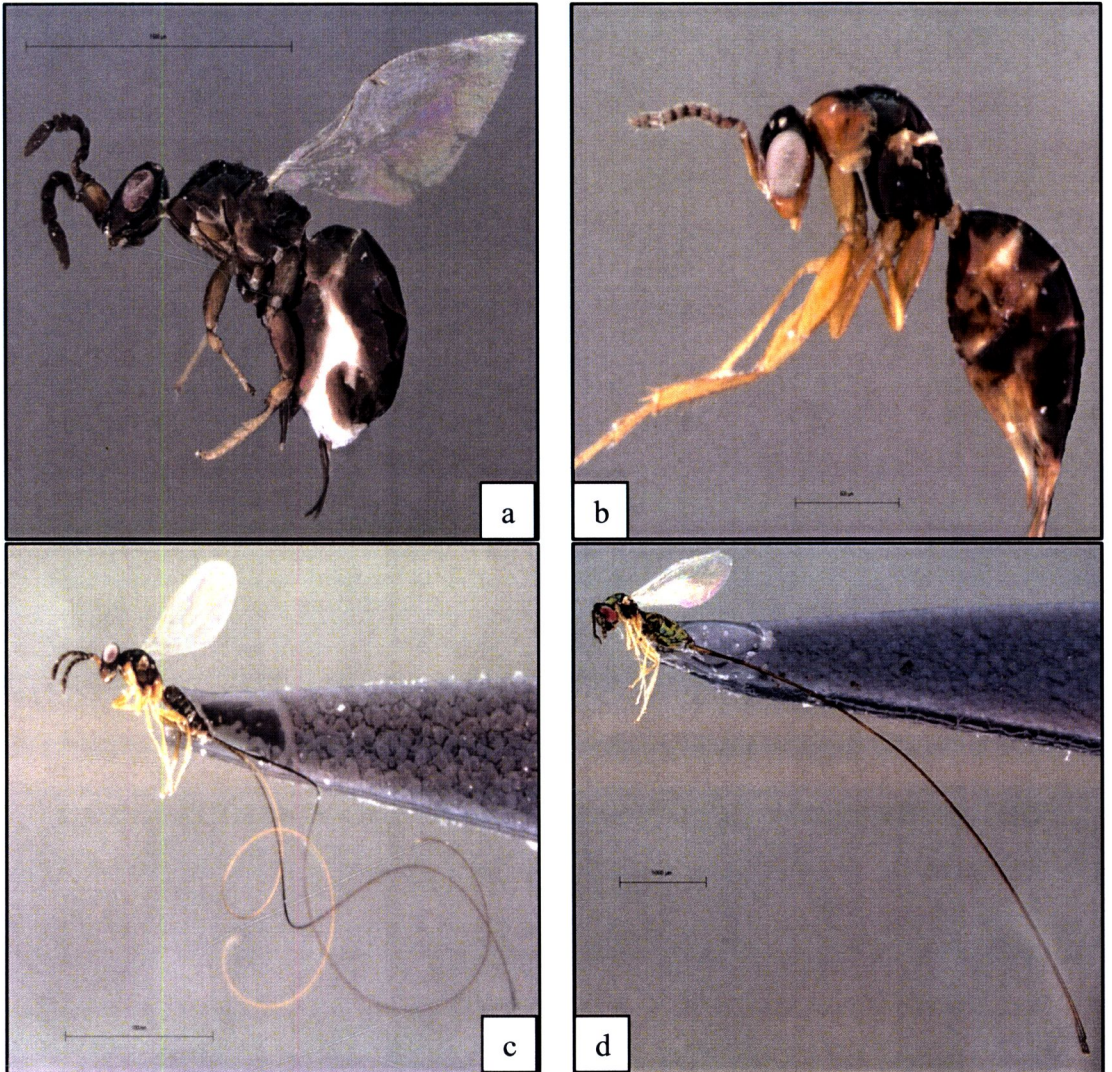
**THE ILLUSTRATIONS OF THE FIG WASPS DEVELOPING IN FIGS OF
FICUS TRILOBA IN DOI SUTHEP-PUI NATIONAL PARK,
NORTHERN, THAILAND**



(a) *Vilisia esquiroliana*, (b) head of *Vilisia esquiroliana*, (c) *Sycoscapter* sp1 and (d) *Sycoscapter* sp2.

APPENDIX H

**THE ILLUSTRATIONS OF THE FIG WASPS DEVELOPING IN FIGS OF
FICUS VARIEGATA IN DOI SUTHEP-PUI NATIONAL PARK,
NORTHERN, THAILAND**



(a) *Ceratosolen appendiculatus*, (b) *Philotrypesis bimaculata*, (c) *Platyneura spinitarsus* and (d) *Sycoscapter patellaris*.

APPENDIX I

LARVA ECOLOGY OF NON-POLLINATING FIG WASPS FROM THE PREVIOUS STUDIES

Genus	Larval ecology
<i>Apocrypta</i>	1) Parasitoid of pollinator (Abdurahiman and Joseph, 1979; Abdurahiman, 1986; Kerdelhué and Rasplus, 1996; Murray, 1990; Kerdelhué <i>et al.</i>, 2000; Weiblen <i>et al.</i>, 2001; Xu <i>et al.</i>, 2003; Proffit <i>et al.</i>, 2007; Wang and Zheng, 2008; Peng <i>et al.</i>, 2005; Sun <i>et al.</i>, 2008). 2) Parasitoid of <i>Apocryptophagus</i> (Godfray, 1988; Weiblen <i>et al.</i>, 2001; Weiblen, 2002). 3) Parasitoid of <i>Philotrypesis</i> (Compton <i>et al.</i>, 1994; Peng <i>et al.</i>, 2005). 4) Parasitoid of <i>Platyneura</i> (Ulenberg, 1985; Silvius <i>et al.</i>, 2007; Sun <i>et al.</i>, 2008). 5) Inquiline (Galil and Eisikowich, 1968; Pereira <i>et al.</i>, 2007). 6) Seed predator (Jansen, 1979).
<i>Philotrypesis</i>	1) Inquiline (Bajinath and Ramcharun, 1988; Compton <i>et al.</i>, 1988; Peng <i>et al.</i>, 2005; Shi <i>et al.</i>, 2006; Proffit <i>et al.</i>, 2007; Pereira <i>et al.</i>, 2007; Zhai <i>et al.</i>, 2008; Harrison <i>et al.</i>, 2008). 2) Cleptoparasite (Abdurahiman, 1986; Cook and Rasplus, 2003). 3) Parasitoid (Abdurahiman, 1986; Godfray, 1988; Compton <i>et al.</i>, 1994; Murray, 1990; Joseph, 1958 in Jiang <i>et al.</i>, 2006; Weiblen <i>et al.</i>, 2001; Silvius <i>et al.</i>, 2007).

Genus	Larval ecology
<i>Platynuera</i>	1) Gall-maker (Shi <i>et al.</i>, 2006; Proffit <i>et al.</i>, 2007; Silvius <i>et al.</i>, 2007; Sun <i>et al.</i>, 2008; Kuaraksa, per. obs., 2009). 2) Parasitoid (Xu <i>et al.</i>, 2003; Elias <i>et al.</i>, 2008). 3) Seed predator (Compton <i>et al.</i>, 1991).
<i>Sycosapter</i>	1) Inquiline (Shi <i>et al.</i>, 2006). 2) Parasitoid (Godfray, 1988; Boucek, 1993; Compton <i>et al.</i>, 1994; Laman and Weiblen, 1998; Weiblen <i>et al.</i>, 2001; Cook & Lopez-Vaamonde, 2001; Silvius <i>et al.</i>, 2007; Tzeng <i>et al.</i>, 2008). 3) Phytophagous kleptoparasites (Boucek, 1993 in Lopez-Vaamonde <i>et al.</i>, 2001).

APPENDIX J

**ESTABLISHMENT AND MAINTENANCE COSTS OF THREE PLANTING
STOCK TYPES WERE RECORDED THROUGHOUT THE STUDY
PERIOD (BAHT PER PLANT)**

Items	Direct Seeding	Planting stock-raised		Planting stock-raised	Note
		in nursery	in nursery		
		from seed	from cutting		
Materials					
Germination tray	-	0.09	-		104 holes/20 baht/2 times used
Black plastic bags 2"x5"	-	-	0.13		333 bags/kg/45 baht
Black plastic bags 2.5"x9"	-	0.19	0.19		236 bags/kg/45 baht
Clear plastic bags	-	-	0.25		3 baht/bag, 1 bag contain 12 cuttings
Forest soil	-	0.21	0.21		362.12 cm ³ x 0.00059 baht
Peanut husk	-	0.13	0.13		181.06 cm ³ x 0.0007 baht
Coconut husk	-	0.1	0.1		181.06 cm ³ x 0.0006 baht
Sand	-	0.03*	0.1**		* 47.73 cm ³ x 0.0008; ** 128.755 cm ³ x 0.0008 baht
Charred rice husk	-	0.02*	0.07**		* 47.73 cm ³ x 0.0006 baht; ** 128.755 cm ³ x 0.0006 baht
Osmocote	-	0.04*	0.08**		* 0.3 g, 150 baht/kg, 1 time; ** 0.3 g, 150 baht/kg, 2 times
Rooting hormone	-	-	0.07		1,200 cuttings/80 baht
Bamboo stake	0.25	0.25	0.25		200 stakes/50 baht
Bamboo tube	0.06	-	-		50 tubes/ 3 baht

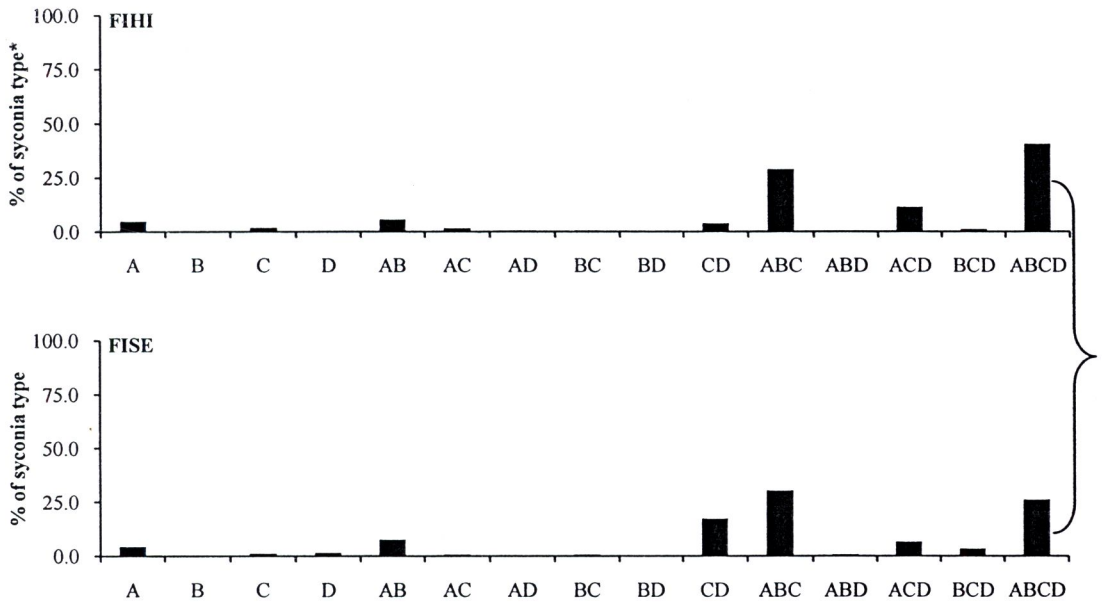
Items	Direct Seeding	Planting stock-raised		Note
		in nursery	in nursery from seed	
Materials				
Rabbit fertilizer	2.4*	5.6**	5.6**	* 50 kg/800 baht/1,000 seedlings, 3 times; ** 7 times
Gasoline	-	0.33	0.33	1,500 seedlings/500 baht
Labor				
Seed collection	0.008	0.008	-	3,000 seeds/hour
Seed preparation	0.016	0.016	-	3,000 seeds/ 2 hours
Seed sowing	1.48*	0.075**	-	* 540 holes/4 persons/4 hours; ** 100 seeds/ 1.5 hours
Cutting collection	-	-	0.25	100 cuttings/ hour/ person
Cutting preparation	-	-	0.33	300 cuttings/4 hours/person
Cutting action	-	-	0.54	216 cuttings/ 4 persons/ 4 hours
Bamboo tube preparing	0.2	-	-	1,000 tubes/ 8 hours/ person
Watering (before potting)	-	1.73	-	10,400 seeds/ 2 hours/ 2 times per day x 180 days
Watering (in propagator)	-	-	7.4	8 times/ 216 cuttings/ 2 persons/ 4 hours
Potting	-	0.4*	0.66**	* 500 seedlings/ 8 hours/ person; ** 300 seedling

Items	Direct Seeding	Planting stock-raised		Planting stock-raised	Note
		in nursery	from seed		
Labor					
Fertilizing (in nursery)	-	0.06*	0.125**		* 400 seedlings/ hour/ 1 time; ** 2 times
Watering (after potting)	-	1.875*	2.625**		* 2,000 seedlings/ hour/150 days; ** 210 days
Weeding (in nursery)	-	0.2	0.2		500 seedlings/ 4 hours/ person
Grading	-	0.05	0.05		500 seedlings/ hour/ person
Seedling transferring	-	0.8	0.8		1,500 seedlings/ 6 persons/ 4 hours
Driver	-	0.06	0.06		1, 500 seedlings/ 4 hours/ person
Planting	-	2	2		500 seedlings/ 4 hours/ 5 persons
Weeding (after planting)	8.4	8.4	8.4		500 seedlings/ 3 persons/ 8 hours/ 7 times
Fertilizing (after planting)	0.6*	1.4**	1.4**		* 500 seedlings/ 4 hours/ person/ 3 times; ** 7 times

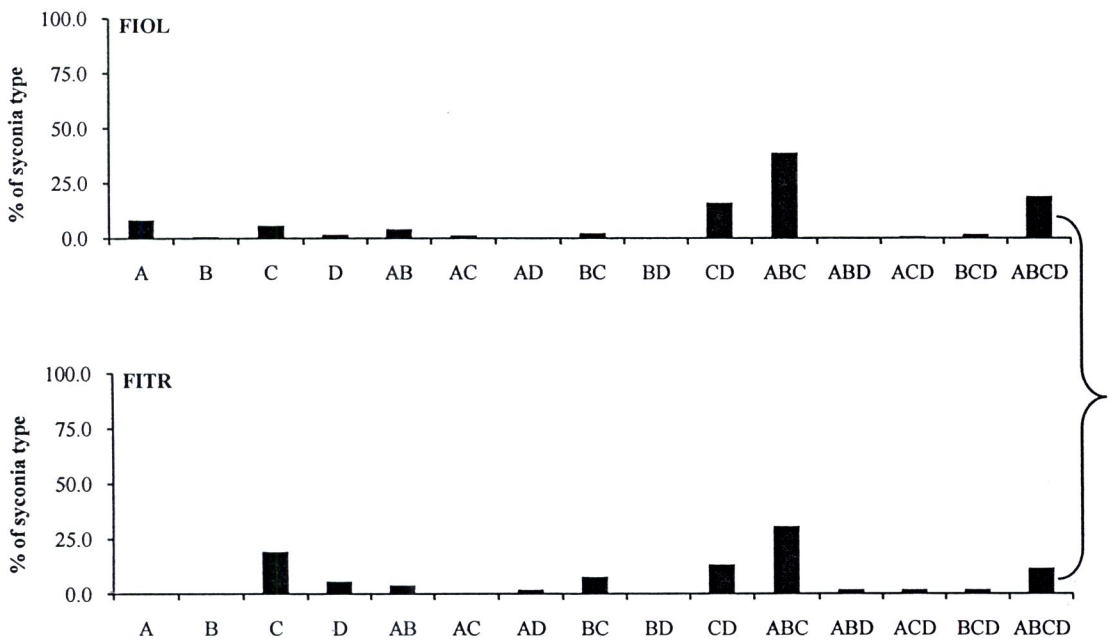
During the period of study, manual cost average 200 baht per day (8 hours).

APPENDIX K

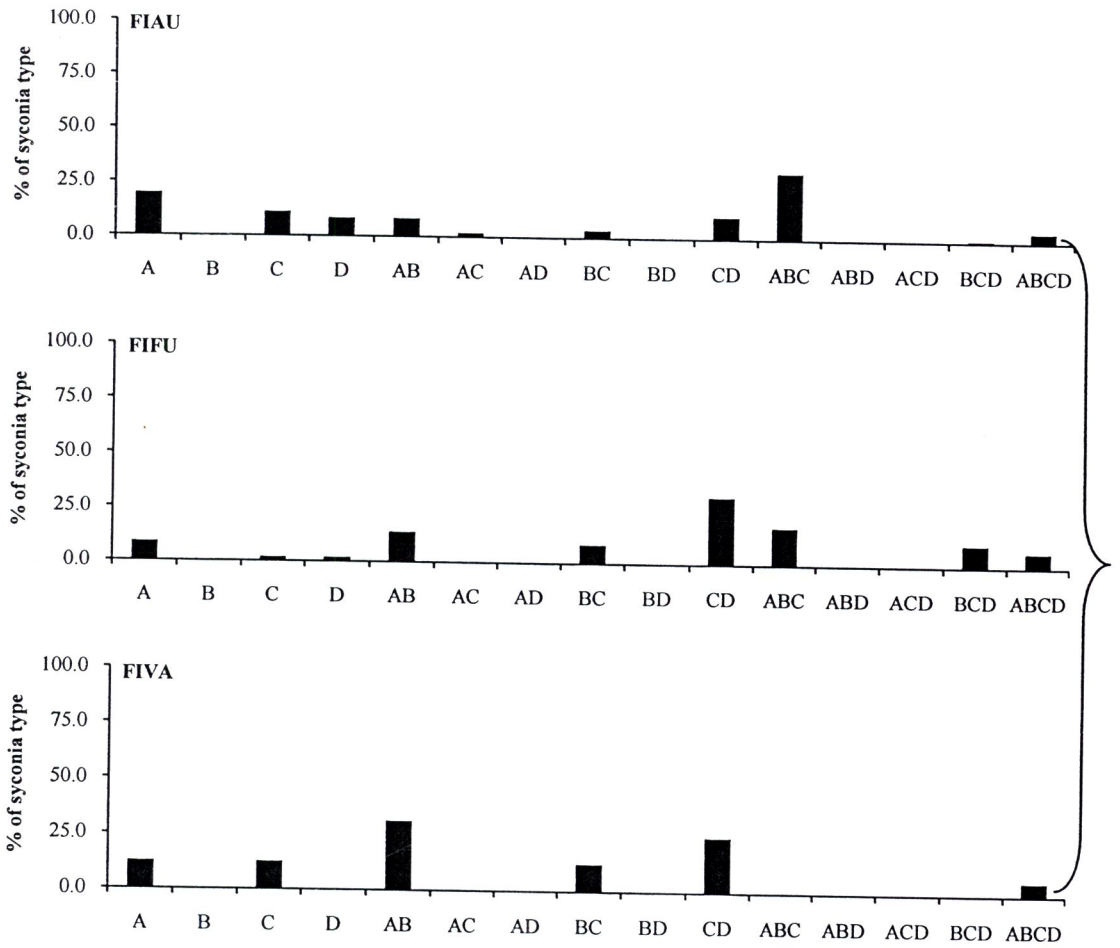
TYPE OF SYCONIA DEVELOPMENTS WITHIN MALE TREES OF SEVEN SELECTED FIG SPECIES



1. Species with high degree of within-tree reproductive asynchrony; A, B, C and D represent syconia in the immature-, receptive-, developing- and releasing-phases, respectively. *= % of individuals of the type in total individual observed.



2. Species with moderate degree of within-tree reproductive asynchrony.



3. Species with low degree of within-tree reproductive asynchrony.

CURRICULUM VITAE

Name	Mr. Cherdsak Kuaraksa
Date of birth	January 10, 1974
Education background	
High School Certificate	Phatthalung School, 1993
B.Sc. (Agriculture)	Department of Agricultural Extension, Faculty of Agriculture, Chiang Mai University, Chiang Mai, Thailand, 50200, 1997
M.Sc. (Biology)	Department of Biology, Faculty of Science, Chiang Mai University, Chiang Mai, Thailand 50200, 2002
Work experience	
1997-1998	Researcher Assistant, Chiang Dao Wildlife Sanctuary, Chiang Mai, Royal Forestry Department, Thailand
1998-2002	Researcher, Forest Restoration Research Unit, Department of Biology, Faculty of Science, Chiang Mai University, Chiang Mai, Thailand, 50200
2002-2007	Research Manager, Forest Restoration Research Unit, Department of Biology, Faculty of Science, Chiang Mai University, Chiang Mai, Thailand 50200

Training course

- | | |
|------|--|
| 2001 | Propagation of forest tree species, ASEAN-CANADA Forest Tree Seed Centre Project, Muak-Lek, Saraburi, Thailand |
| 2005 | Tree Nursery Management, Eden Project, Cornwall, U.K. |
| 2009 | Plant-pollinator mutualisms, Centre d'Ecologie Fonctionnelle et Evolutive, Montpellier, France |

Fields of speciation

1. Forest restoration
2. Tropical plant ecology
3. Plant propagation, Agroforestry

Publications

- Blakesley, D., Anusarnsunthorn, V., Kerby, J., Navakitbumrung, P., **Kuaraksa, C.**, Zangkum, S., Hardwick, K. and Elliott, S. 2000. Nursery technology and tree species selection for restoring forest biodiversity in northern Thailand. In: Elliott, S., Kerby, J., Blakesley, D., Hardwick, K., Woods, K. and Anusarnsunthorn, V. (eds.), *Forest restoration for wildlife conservation*. Chiang Mai University, Thailand, pp. 207-222.
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- Elliott, S. and **Kuaraksa, C.** 2008. Producing framework tree species for restoring forest ecosystems in Northern Thailand. *Small-scale Forestry*, 7(3-4): 403-415.
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- Elliott, S., Navakitbumrung, P., **Kuaraksa, C.**, Zangkum, S., Anusarnsunthorn, V., and Blakesley, D. 2003. Selecting framework tree species for restoring seasonally dry tropical forests in northern Thailand based on field performance. *Forest Ecology and Management*, 184: 177-191.
- Elliott, S., Anusarnsunthorn, V., Maxwell, J.F., Gale, G., Toktang, T., **Kuaraksa, C.**, Navakitbumrung, P. Pakkad, G. Tunjai, P., Thaiying, J. and Blakesley, D. 2004. How to Plant a Forest. Proceedings of the Annual Biodiversity Research and Training Symposium, Oct 2004.
- Elliott, S., **Kuaraksa, C.**, Tunjai, P., Toktang, T., Boonsai, K., Zangkum, S., Suwanaratana, S. and Blakesley, D. 2007. Integrating scientific research with community needs to restore a forest landscape in northern Thailand. IUFRO Conference on forest landscape restoration, pp. 35-36.
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Scholarships

- | | |
|------|---|
| 2000 | Thailand's Biodiversity Research and Training Program (BRT);
“Factors affecting growth of wildlings in the forest and nurturing methods in nursery”. |
|------|---|

- 2007 International Foundation for Science (IFS); “Propagation and field trials of threatened tree species for conservation in northern Thailand”.
- 2008 The Royal Golden Jubilee Ph.D. Program, Thailand Research Fund.

Presentations

- 14-16 September 2005 Oral presentation on ‘How to plant a tropical forest’. The Rainforest Gathering Conference, 14-16 September 2005, Eden Project, Cornwall, U.K.
- 21-23 March 2007 Oral presentation on ‘Seedling production for forest restoration’. Royal Forestry Department Annual Conference, Chiang Mai Empress, Thailand.
- 1-3 April 2010 Oral presentation on ‘Reproductive ecology and propagation of fig trees (*Ficus* spp.) as framework trees for forest restoration’. RGJ-Ph.D. Congress XI, Jomtein Palm Beach Hotel and Resort, Pattaya, Chonburi, Thailand.
- 19-23 July 2010 Oral presentation on ‘The use of fig trees (*Ficus* spp.) in forest restoration plantings’. The 2010 International Meeting of the Association for Tropical Biology and Conservation. Sanur-Denpasar, Bali, Indonesia.



