APPENDICES

APPENDIX A

BMWP score values table

Table 6-1 BMWP score values table (Mustow, 2002)

Order / Class	Family	BMWP score
Cl. Tricladida	Dugesiidae	5
Cl. Oligochaeta	All	1
Cl. Hirudinea	Erpobdellidae	3
	Clossiphoniidae	3
	Hirudidae	3
	Piscicolidae	4
Cl. Bivalvia	Curbiculidae	3
	Shaeriidae	3
Cl. Gastropoda	Hydrobiidae	3
	Triaridae	3
	Viviparidae	6
	Ancylidae	6
	Lymnaeidae	3
	Planorbidae	3
O.Decapoda	Atyidae	8
	Palaemonidae	8
	Parathelphusidae	3
O.Megaloptera	Corydalidae	4
	Sialidae	4
O.Ephemeroptera	Baetidae, Siphonuliidae	4
	Caenidae	7
	Ephemerellidae, Ephemeridae, Hepageniidae, Leptophlebiidae, Potamanthidae	10

Order / Class	Family	BMWP score
O.Odonata	Aeshnidae, Calopterygidae, Chlorocyphidae, Corduliidae, Coenagrioniidae, Macromiidae, Platystictidae, Libellulidae, Gomphidae, Cordulegastridae	6
	Protoneuridae	3
O.Plecoptera	Nemouridae	7
	Perlidae	10
O.Hemiptera	Aphelocheiridae	10
	Corixidae, Gerridae, Pleidae Hydrometridae, Mesoveliidae, Naucoridae, Nepidae, Notonectidae,	5
O.Trichoptera	Goeridae, Lepidostomatidae, Leptoceridae, Molannidae, Odontoceridae, Brachycentridae, Phryganeidae	10
	Philopotamidae, Psychomyiidae	8
	Polycentropodidae, Stenopsychidae, Rhyacophilidae	7
	Hydroptilidae	6
	Hydropsychidae	5
O.Coleoptera	Chrysomelidae, Curculionidae, Dryopidae, Dytiscidae, Elminthidae, Gyrinidae, Haliplidae, Helodidae, Hydrophilidae, Psephenidae	5
O.Diptera	Chironomidae	2
	Simuliidae, Tipulidae	5

Table 6-2 Interpretation of ASPT

ASPT	Water Quality Standard	Detail
1-2	Class 5	Very poor
3-4	Class 4	Fairly poor
5-6	Class 3	Moderate
7-8	Class 2	Fairly good
9-10	Class 1	Good

Modified by Lotic Insect Ecology Research Unit, Department of Biology, Science Faculty, Chiang Mai University.

APPENDIX B

HBI Tolerance Value Tables

Table 6-3 HBI Tolerance Value Tables (Hilsenhoff, 1987)

Superphylum Arthropoda

Phylum Entoma

Order / Class	Family / Species	Tolerance
Cl. Collembola (springtails)	*Isotomurus* sp.	5
O. Ephemeroptera (mayflies)	Ameletidae	0
	Baetidae	5
	Baetiscidae	4
	Caenidae	6
	Ephemerellidae	1
	Ephemeridae	3
	Heptageniidae	3
	Isonychiidae	2
	Leptophlebiidae	3
	Leptohyphidae	4
	Metretopodidae	2
	Oligoneuriidae	2
	Polymitarcyidae	2
	Potomanthidae	4
	Siphlonuridae	4
	Tricorythidae	4
O. Odonata (dragonflies and damselflies)	Aeshnidae	3
	Calopterygidae	6
	Coenagrionidae	8
	Cordulegastridae	3

Order / Class	Family / Species	Tolerance
	Corduliidae	2
	Gomphidae	3
	Lestidae	6
	Libellulidae	2
	Macromiidae	2
O. Plecoptera (stoneflies)	Capniidae	2
	Chloroperlidae	0
	Leuctridae	0
	Nemouridae	2
	Peltoperlidae	0
	Perlidae	2
	Perlodidae	2
	Pteronarcyidae	0
	Taeniopterygidae	2
O. Hemiptera	Corixidae	5
O. Trichoptera (caddisflies)	Apataniidae	1
	Brachycentridae	1
	Calamoceratidae	3
	Dipseudopsidae	5
	Glossosomatidae	1
	Goeridae	3
	Helicopsychidae	3
	Hydropsychidae	4
	Hydroptilidae	4
	Lepidostomatidae	1
	Leptoceridae	4
	Limnephilidae	3
	Molannidae	6
	Odontoceridae	0
	Philopotamidae	3

Order / Class	Family / Species	Tolerance
	Phryganeidae	4
	Polycentropodidae	6
	Psychomyiidae	2
	Rhyacophilidae	1
	Sericostomatidae	3
	Uenoidae	3
O. Lepidoptera (butterflies and moths)	Arctiidae	5
	Nepticulidae	5
	Pyralidae	5
O. Coleoptera (beetles)	Curculionidae	5
	Dryopidae	5
	Dytiscidae	5
	Elmidae	4
	Gyrinidae	4
	Haliplidae	5
	Hydrophilidae	5
	Psephenidae	4
	Ptilodactylidae	3
	Scirtidae	5
O. Megaloptera (fishflies, dobsonflies, alderflies)	Corydalidae (fishflies, dobsonflies, hellgrammites)	4
	Sialidae (alderflies)	4
O. Neuroptera	*Climacia* sp.	5
O. Diptera (Two-winged or "true flies")	Anthomyiidae (root maggot flies)	6
	Athericidae	4
	Blephariceridae (net-winged midges)	0
	Ceratopogonidae	6
	Chaoboridae (phantom midges)	8

Order / Class	Family / Species	Tolerance
F. Chironomidae (non-biting or true midges)	F.Chironomidae, Blood-red (Chironomini)	8
	F.Chironomidae, Other (including pink)	6
	Subfamily Tanypodinae	7
	Subfamily Podonominae	1
	Subfamily Diamesinae	2
	Subfamily Prodiamesinae	7
	Subfamily Orthocladiinae	6
	Subfamily Chironominae	6
	Culicidae (mosquitoes)	8
	Dolichopodidae	4
	Dixidae (dixid midges)	1
	Dolochopodidae	4
	Empididae (dance flies)	6
	Ephydridae (shore flies, brine flies)	6
	Muscidae	6
	Psychodidae (moth flies)	8
	Ptychopteridae	9
	Scathophagidae (dung flies)	6
	Simuliidae (black flies)	6
	Stratiomyidae (soldier flies)	7
	Syrphidae	10
	Tabanidae (horse and deer flies)	5
	Tanyderidae	3
	Tipulidae (crane flies)	3

Subphylum Chelicerata

Order / Class	Family / Species	Tolerance
C. Arachnida		
O. Acariformes	Arrenuridae	6
	Lebertiidae	6
	Atractideidae	6
	Mideopsidae	6
	Tyrellidae	6
	Limnesidae	6
	Limnocharidae	6
	Sperchonidae	6
	Unionicolidae	6
C. Diplopoda	Polydesmidae	6

Subphylum Crustacea

Order / Class	Family / Species	Tolerance
O. Isopoda (sow bugs)	Anthuridae	5
	Idoteidae	5
	Asellidae	8
O. Amphipoda (scuds; side swimmers)	Crangonyctidae	6
	Gammaridae	6
	Oedicerotidae	5
	Talitridae/Hyalellidae	8
O. Cumacea		5
O. Decapoda (shrimps, crabs, etc.)		6
O. Cladocera (water fleas)	*Daphnia*	8
Subclass Copepoda	Cyclopoida	8
C. Ostracoda (seed shrimps)		8

Phylum Mollusca

Order / Class	Family / Species	Tolerance
C. Gastropoda (snails and limpets)	Basommatophora (pulmonates)	
	Physidae	8
	Lymnaeidae	6
	Planorbidae	7
	Ancylidae	6
	Mesogastropoda (prosobranches)	
	Viviparidae	6
	Pleuroceridae	6
	Bithyniidae	8
	Hydrobiidae	6
	Valvatidae	8
C. Pelecypoda/Bivalvia		8
	Unionida	6
	Unionidae	
	Veneroidea	6
	Corbiculidae (Asian clams)	8
	Dreisseniidae	6
	Sphaeriidae	8
	Pisidiidae	

Phylum Annelida

Order / Class	Family / Species	Tolerance
C. Oligochaeta (aquatic worms)		8
	Haplotaxida	
	Haplotaxidae	5
	Lumbricida	6
	Lumbriculida	
	Lumbriculidae	5

Order / Class	Family / Species	Tolerance
	Tubificida	
	Enchytraeidae	10
	Tubificidae	9
	Naididae	8
C. Hirudinea	Bdellidae	10
	Glossiphoniidae	
	Helobdella	6
	Other Glossiphoniidae	8
C. Aphanoneura	Aeolosomatida	8
	Aeolosomatidae	
C. Branchiobdellida (leech-like ectosymbionts)	Branchiobdellida	6
	Branchiobdellidae	
C. Polychaeta (freshwater tube worms)	Sabellidae	6

Phylum Platyhelminthes

Order / Class	Family / Species	Tolerance
C. Turbellaria		4
(planarians/dugesia)	Platyhelminthidae	4

Phylum Coelenterata

Order / Class	Family / Species	Tolerance
	Hydridae	5
	Hydra sp.	

Phylum Nemertea (ribbon worms)

Order / Class	Family / Species	Tolerance
	Tetrastemmatidae	8
	Prostoma graecense	

Table 6-4 Interpretation of HBI Scores

HBI	Water Quality	Degree of Organic Pollution
0.00-3.5	excellent	no apparent organic pollution
3.51-4.5	very good	possible slight organic pollution
4.51-5.50	good	some organic pollution
5.51-6.50	fair	fairly significant organic pollution
6.51-7.50	fairly poor	significant organic pollution
7.51-8.50	poor	very significant organic pollution
8.51-10.00	very poor	severe organic pollution

APPENDIX C

Biological and Chemical Analysis

I. Total Coliform Bacteria Analysis (วันชัย, 2537)

Multiple- Tube Fermentation

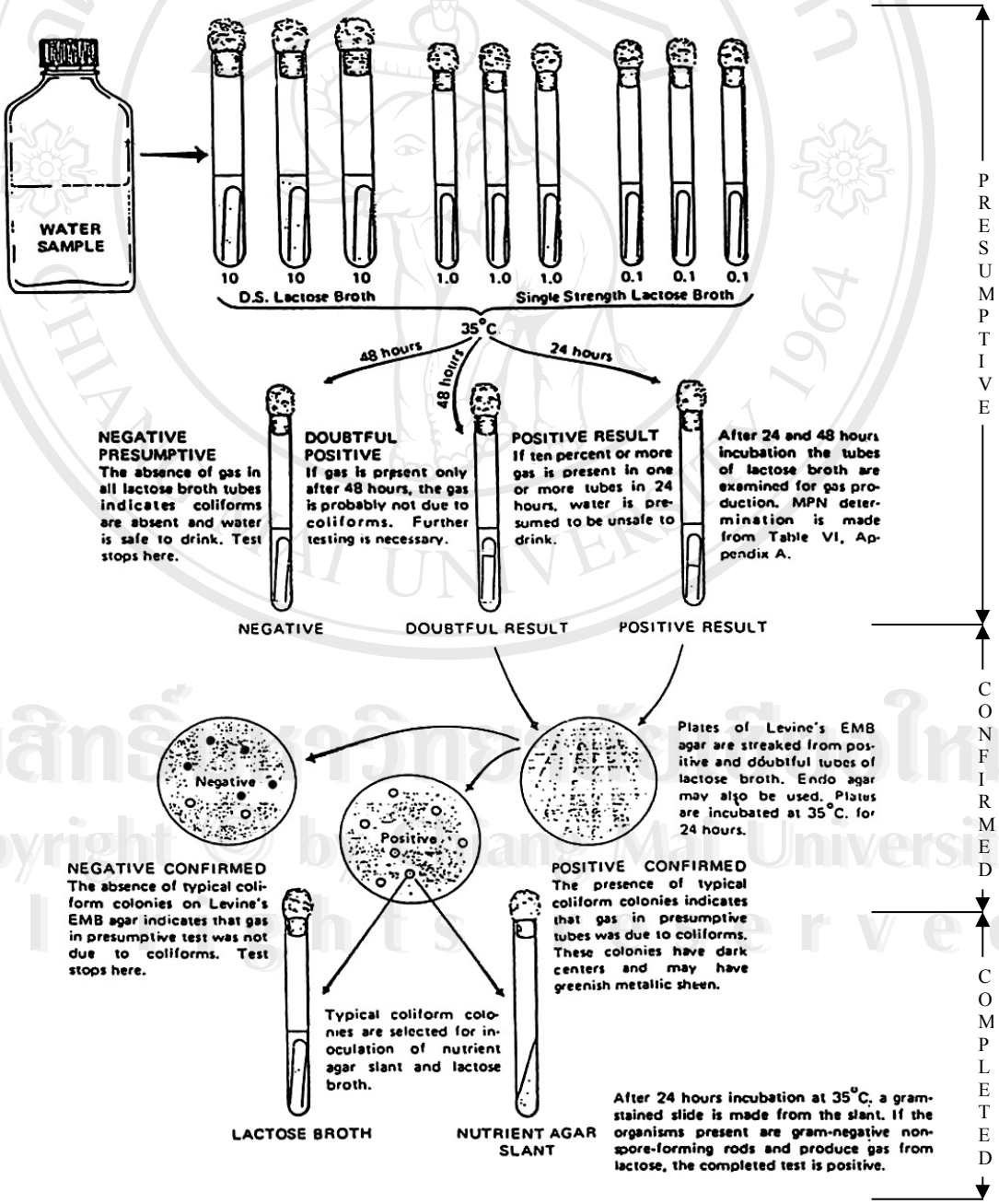


Table 6-5 MPN Determination from Multiple Tube Test

Number of tubes giving positive reaction out of			MPN/100 ml
3 of 10 ml. each	3 of 1 ml. each	3 of 0.1 ml. each	
0	0	0	<3
0	0	1	3
0	1	0	3
1	0	0	4
1	0	1	7
1	1	0	7
1	1	1	11
1	2	0	11
2	0	0	9
2	0	1	14
2	1	0	15
2	1	1	20
2	2	0	21
2	2	1	28
3	0	0	23
3	0	1	39
3	0	2	64
3	1	0	43
3	1	1	75
3	1	2	120
3	2	0	93
3	2	1	150
3	2	2	210
3	3	0	240
3	3	1	460
3	3	2	1100
3	3	3	≤2400

II. Alkalinity: Titration Method

Reagents:

a) 0.05 N Sodium carbonate solution

b) 0.1 N Standard sulfuric acid (or hydrochloric acid)

$$Normality, N = \frac{A \times B}{53.00 \times C}$$

Where,

A = g Na_2CO_3 weighed into 1-L flask

B = mL Na_2CO_3 solution taken for titration, and

C = mL acid used.

c) 0.02 N Standard sulfuric acid or hydrochloric acid

d) Bromocresol green indicator solution, pH 4.5 indicator

e) Mixed bromocresol green-methyl red indicator solution

f) Metacresol purple indicator solution, pH 8.3 indicator

g) Phenolphthalein solution, alcoholic, pH 8.3 indicator

h) 0.1 N sodium thiosulfate

Procedure:

a) 25 mL of sample was pipetted into Erlenmeyer flask

b) Added 5 drops of indicator (mixed bromocresol green-methyl red)

c) Titrated with 0.02 N hydrochloric acid and color changed from blue to orange pink, volume of titrant was recorded and calculation was made from the following formula below.

Calculation:

$$Totalalkalinity = \frac{A \times N \times 50{,}000}{Sample(mL)}$$

Where,

A = mL standard acid used, and

N = normality of standard acid

Sample size = 25 mL

III. Dissolved Oxygen (DO): Azide Modification Method

Reagents:

a) Manganese sulfate solution:

Dissolved 480 g $MnSO_4$. $4H_2O$, 400 g $MnSO_4$. $2H_2O$, or 364 g $MnSO_4$. H_2O in distilled water, filter, and dilute to 1 L. The manganese sulfate solution should not give a color with starch when added to an acidified KI solution.

b) Alkali-iodide-azide reagent:

Dissolved 550 g NaOH (or 700 g KOH), and 135 g NAI, (or 150 g KI) in distilled water and dilute to 1 L. Add to 10 g sodium azide, NaN_3, and dissolved in 40 mL distilled water. Potassium and sodium salts may be used interchangeably. This reagent should not show a color with starch solution when diluted and acidified.

c) Sulfuric acid, H_2SO_4, conc:

One milliliter is equivalent to about 3 mL alkali-iodide-azide reagent.

d) Starch:

Use either the aqueous solution or soluble starch powder mixtures.

To prepare the aqueous solution, dissolve 2 g laboratory-grade soluble starch and 0.2 g salicylic acid, as a preservative, in 100 mL hot distilled water.

e) Standard sodium thiosulfate titrant:

Dissolving 6.205 g $Na_2S_2O_3$. $5H_2O$ in distilled water. Add 1.5 mL 6N NaOH or 0.4 g solid NaOH and dilute to 1,000 mL. Standardize with bi-iodate solution.

f) Standard potassium bi-iodate solution, 0.0021 M:

Dissolve 812.4 mg $KH(IO_3)_2$ in distilled water and dilute to 1,000 mL.

Standardization:

Dissolve approximately 2 g KI, free from iodate, in an Erlenmeyer flask with 100 to 150 mL distilled water. Add 1 mL 6N H_2SO_4 or a few drops of conc H_2SO_4 and 20.00 mL standard bi-iodate solution. Dilute to 200 mL and titrate liberated iodine with the thiosulfate titrant, adding starch toward the end of titration, when a pale straw

color is reached. When the solutions are of equal strength, 20.00 mL 0.0250M $Na_2S_2O_3$ should be required. If not, adjust the $Na_2S_2O_3$ solution to 0.025M.

Procedure:

a) To the sample collected in a 250 to 300 mL bottle, add 1 ml manganese sulfate solution, followed by 1 mL alkali-iodide-azide reagent. If pipets are dipped into ample, rinse them before returning them to reagent bottles. Alternatively, hold pipet tips just above liquid surface when adding reagents. Stopper carefully to exclude air bubbles and mix by inverting bottle a few times. When precipitates have settled sufficiently (to approximately half the bottle volume) to leave clear supernate above the manganese hydroxide floc, add 1.0 mL conc H_2SO_4. Restopper and mix by inverting several times until dissolution is complete. Titrate a volume corresponding to 200 mL original sample after correction for sample loss by displacement with reagents. Thus, for a total of 2 mL (1 mL each) of $MnSO_4$ and alkali-iodide-azide reagents in a 300 mL bottle, titrate 200 X 300/ (300-2) = 201 mL.

b) Titrate with 0.025M $Na_2S_2O_3$ solution to a pale straw color. Add a few drops of starch solution and continue titration to the first disappearance of blue color. If end point is overrun, back-titrate with 0.0021M bi-iodate solution added dropwise, or by adding a measured volume of treated sample. Correct for amount of bi-iodate solution or sample. Disregard subsequent recolorations due to the catalytic effect of nitrite or to traces of ferric salts that have not been complexed with fluoride.

Calculation:

For titration of 200 mL sample, 1 mL 0.025M $Na_2S_2O_3$ = 1 mg DO/L.

IV. Biochemical Oxygen Demand (BOD): Direct Method

Reagent:

See in DO (Azide Modification Method)

Procedure:

a) Collect sample with BOD bottle.

b) Measure DO (DO_1) by using the Azide modification method.

c) Collect sample with BOD (dark) bottle and keep them in incubator (20 ^{o}C) for 5 days. Measure DO (DO_2) by using the same method.

Calculation:

$$BOD\ (mg/L) = DO_1 - DO_2$$

APPENDIX D

Surface Water Quality Standards of Thailand

Table 6-6 Surface Water Quality Standards of Thailand

Parameter	Units	Statistics	Standard Value for Class					Methods for Examination
			Class 1	Class 2	Class 3	Class 4	Class 5	
1. Colour,Odour and Taste	-	-	n	n'	n'	n'	-	-
2. Temperature	C°	-	n	n'	n'	n'	-	Thermometer
3. pH	-	-	n	5-9	5-9	5-9	-	Electrometric pH Meter
4. Dissolved Oxygen (DO)[2/]	mg/l	P20	n	6.0	4.0	2.0	-	Azide Modification
5. BOD (5 days, 20°C)	mg/l	P80	n	1.5	2.0	4.0	-	Azide Modification at 20°C , 5 days
6. Total Coliform Bacteria	MPN/ 100 ml	P80	n	5,000	20,000	-	-	Multiple Tube Fermentation Technique
7. Fecal Coliform Bateria	MPN/ 100 ml	P80	n	1,000	4,000	-	-	Multiple Tube Fermentation Technique
8. NO_3 –N	mg/l	-	n	5.0			-	Cadmium Reduction
9. NH_3 –N	mg/l	-	n	0.5			-	Distillation Nesslerization
10.Phenols	mg/l	-	n	0.005			-	Distillation,4-Amino antipyrene
11.Copper (Cu)	mg/l	-	n	0.1			-	Atomic Absorption – Direct Aspiration
12.Nickle (Ni)	mg/l	-	n	0.1			-	Atomic Absorption – Direct Aspiration
13.Manganese (Mn)	mg/l	-	n	1.0			-	Atomic Absorption – Direct Aspiration
14.Zinc (Zn)	mg/l	-	n	1.0			-	Atomic Absorption – Direct Aspiration
15.Cadmium (Cd)	mg/l	-	n	0.005* 0.05**			-	Atomic Absorption – Direct Aspiration
16.Chromium Hexavalent	mg/l	-	n	0.05			-	Atomic Absorption – Direct Aspiration

Table 6-6 (continued)

Parameter	Units	Statistics	Standard Value for Class					Methods for Examination
			Class 1	Class 2	Class 3	Class 4	Class 5	
17.Lead (Pb)	mg/l	-	n	0.05			-	Atomic Absorption – Direct Aspiration
18.Total Mercury (Total Hg)	mg/l	-	n	0.002			-	Atomic Absorption-Cold Vapour Technique
19.Arsenic (As)	mg/l	-	n	0.01			-	Atomic Absorption - Direct Aspiration
20.Cyanide (Cyanide)	mg/l	-	n	0.005			-	Pyridine-Barbituric Acid
21.Radioactivity - Alpha - Beta	Becq urel/l	-	n	0.1 1.0			-	Gas-Chromatography
22.Total Organochlorine Pesticides	mg/l	-	n	0.05			-	Gas-Chromatography
23.DDT	µg/l	-	n	1.0			-	Gas-Chromatography
24.Alpha-BHC	µg/l	-	n	0.02			-	Gas-Chromatography
25.Dieldrin	µg/l	-	n	0.1			-	Gas-Chromatography
26.Aldrin	µg/l	-	n	0.1			-	Gas-Chromatography
27.Heptachlor & Heptachlorepoxide	µg/l	-	n	0.2			-	Gas-Chromatography
28.Endrin	µg/l	-	n	None			-	Gas-Chromatography

Remark : P = Percentile value
n = naturally
n' = naturally but changing not more than 3°C
* = when water hardness not more than 100 mg/l as $CaCO_3$
** = when water hardness more than 100 mg/l as $CaCO_3$

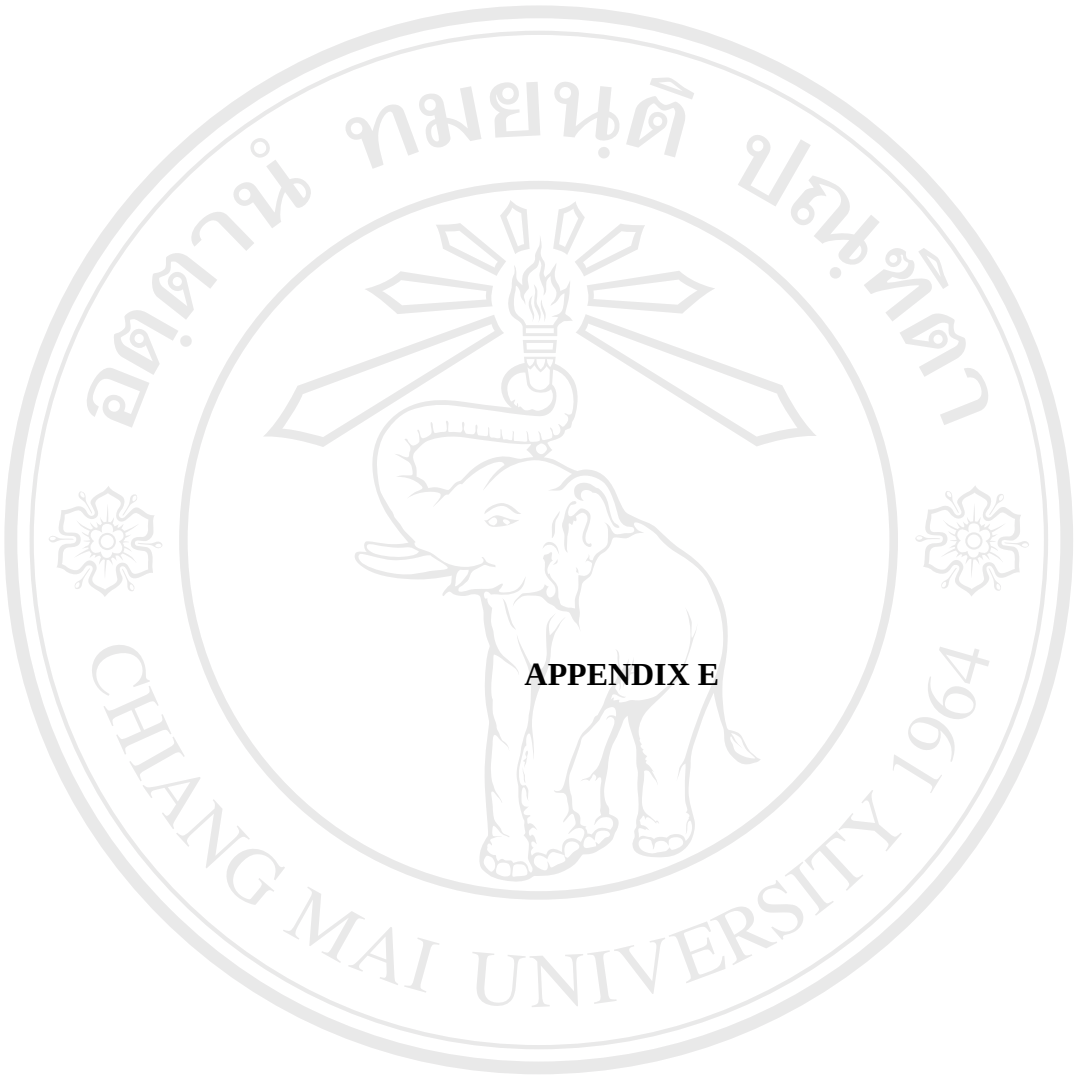
Based on Standard Methods for the Examination of Water and Wastewater recommended by APHA : American Public Health Association, AWWA : American Water Works Association and WPCF : Water Pollution Control Federation.

Source : Notification of the National Environmental Board, No. 8, B.E. 2537 (1994), issued under the Enhancement and Conservation of National Environmental Quality

Act B.E.2535 (1992) , published in the Royal Government Gazette, Vol. 111, Part 16, dated February 24, B.E.2537 (1994).

Table 6-7 Classification and Objectives

Classification	Objectives/Condition and Beneficial Usage
Class 1	Extra clean fresh surface water resources used for : (1) conservation not necessary pass through water treatment process require only ordinary process for pathogenic destruction (2) ecosystem conservation where basic organisms can breed naturally
Class 2	Very clean fresh surface water resources used for : (1) consumption which requires ordinary water treatment process before use (2) aquatic organism of conservation (3) fisheries (4) recreation
Class 3	Medium clean fresh surface water resources used for : (1) consumption, but passing through an ordinary treatment process before using (2) agriculture
Class 4	Fairly clean fresh surface water resources used for : (1) consumption, but requires special water treatment process before using (2) industry
Class 5	The sources which are not classification in class 1-4 and used for navigation.



APPENDIX E

Table 6-8 Results of physical and chemical properties of the Mae Kham Watershed from October to December 2003 (cool dry season).

	Water temp	Air temp	Velocity	Conduct	pH	DO	PO_4^{3-}	NO_3^-	NH_3	Turbidity	Alkalinity	BOD	Coliform
October													
S 1	31.9	32.1	1.2	70.3	6.80	6.8	0.14	0.5	0.34	57	35	0.8	11000
S 2	29.6	35.3	3.2	105.7	6.98	6.6	0.29	0.6	0.20	54	52	1.4	2100
S 3	24.6	28.4	3.5	87.8	7.32	8.2	0.09	0.5	0.14	27	40	1.4	11000
S 4	27.8	34.2	3.0	52.0	6.93	7.4	0.20	0.5	0.20	73	25	1.3	2400
S 5	25.3	28.1	2.8	67.7	7.63	8.2	0.37	0.7	0.12	47	35	1.0	11000
S 6	24.8	25.9	1.8	60.9	6.94	7.6	0.34	0.5	0.10	40	27	0.8	4600
S 7	25.4	26.0	3.3	89.5	7.50	8.6	0.18	0.5	0.13	54	45	0.8	430
S 8	25.3	30.2	2.0	96.8	7.33	7.6	0.28	0.7	0.11	42	49	0.8	1500
December													
S 1	17.4	15.5	0.4	60.6	8.30	6.8	0.01	1.3	0.33	27	33	3.3	11000
S 2	19.0	16.4	1.9	164.0	8.30	6.4	0.01	0.9	0.26	22	82	1.0	4600
S 3	18.9	23.0	1.9	99.6	8.90	6.8	0.03	1.2	0.07	21	45	2.3	240
S 4	19.5	19.5	1.8	61.9	8.20	6.2	0.02	1.2	0.10	12	27	1.6	1500
S 5	18.4	24.1	1.5	75.3	9.00	7.8	0.03	0.7	0.13	15	36	3.4	2100
S 6	20.3	23.6	1.4	76.4	9.90	7.0	0.01	0.8	0.11	65	31	2.5	150
S 7	18.5	20.1	2.5	98.7	9.10	7.4	0.03	0.4	0.15	25	45	1.8	1500
S 8	19.0	19.4	1.2	102.2	8.80	6.6	0.04	1.1	0.08	14	48	1.8	930

Table 6-9 Results of physical and chemical properties of the Mae Kham Watershed from March to May 2004 (hot dry season).

	Water temp	Air temp	Velocity	Conduct	pH	DO	PO_4^{3-}	NO_3^-	NH_3	Turbidity	Alkalinity	BOD	Coliform
March													
S 1	19.7	25.0	0.1	88.4	7.64	5.8	0.12	N	0.41	5	35	1.0	240
S 2	22.7	25.1	2.2	169.4	6.99	6.2	0.09	2.2	0.58	27	58	2.0	1100
S 3	18.7	25.2	2.5	108.9	7.25	6.8	0.45	2.0	0.17	7	36	1.6	390
S 4	18.9	25.0	1.2	70.3	6.68	5.8	0.13	2.8	0.14	13	23	0.0	2400
S 5	19.2	25.0	2.0	83.1	7.31	6.8	0.18	3.3	0.22	4	18	0.8	2400
S 6	21.3	25.0	1.2	84.3	7.70	5.4	0.07	2.3	0.18	25	22	1.6	23
S 7	22.2	25.0	1.3	108.5	7.22	6.4	0.35	1.3	0.20	8	36	1.8	460
S 8	20.0	24.4	0.6	106.6	7.20	6.0	0.09	2.1	0.26	6	38	0.4	460
May													
S 1	27.0	32.3	0.9	81.7	7.70	4.8	N	2.6	0.67	45	29	2.4	≤24000
S 2	29.0	32.1	1.5	146.2	7.60	5.0	0.35	0.3	0.85	110	48	1.6	≤24000
S 3	24.2	26.9	0.9	117.9	7.70	5.6	0.33	0.3	0.33	49	41	0.2	1500
S 4	32.0	33.0	1.1	76.4	7.40	5.2	0.27	1.3	0.41	16	18	0.4	11000
S 5	25.8	26.7	2.1	87.2	7.90	5.3	0.38	N	1.25	112	33	1.1	≤24000
S 6	27.1	27.4	1.1	85.1	7.10	5.4	0.20	1.8	0.14	17	25	1.2	≤24000
S 7	26.0	31.1	2.5	117.9	8.10	5.4	0.15	1.8	0.22	36	47	0.2	240
S 8	29.7	28.9	1.1	121.3	8.10	5.4	0.19	1.9	0.15	5	43	1.0	240

N = Non detected

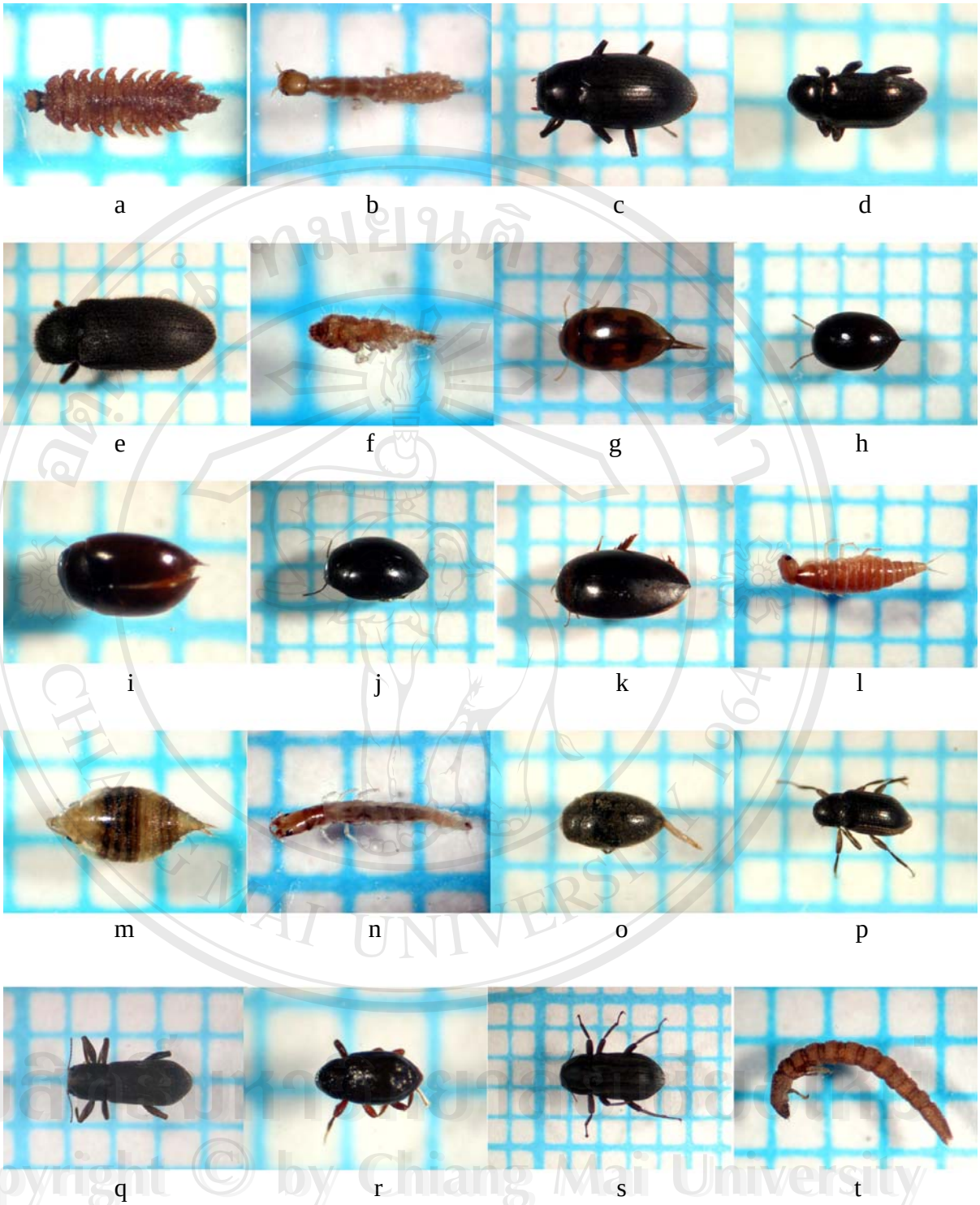
Table 6-10 Results of physical and chemical properties of the Mae Kham Watershed from July to August 2004 (rainy season).

	Water temp	Air temp	Velocity	Conduct	pH	DO	PO_4^{3-}	NO_3^-	NH_3	Turbidity	Alkalinity	BOD	Coliform
July													
S 1	30.0	25.5	0.8	62.7	6.93	5.2	0.12	1.0	0.81	55	34.2	1.2	11000
S 2	29.4	24.5	1.6	118.0	7.25	4.8	0.21	0.9	0.57	48	58.3	1.4	≤24000
S 3	27.2	29.4	2.0	99.1	5.90	5.8	N	1.2	0.38	45	50.5	0.4	≤24000
S 4	29.0	29.8	1.2	62.4	6.89	5.3	0.21	1.1	0.33	18	31	0.1	11000
S 5	26.0	29.2	2.3	64.0	7.69	5.9	0.11	0.2	0.68	184	36.5	0.3	≤24000
S 6	24.2	24.5	1.1	76.0	7.08	6.4	0.21	1.6	0.03	5	35.5	0.8	4600
S 7	27.9	28.0	2.1	103.0	7.67	6.0	0.12	1.5	0.32	36	52	0.1	2400
S 8	-	-	-	-	-	-	-	-	-	-	-	-	-
August													
S 1	33.5	32.5	0.6	51.0	7.00	4.6	0.14	0.2	0.92	83	25.5	0.1	2400
S 2	26.2	29.5	1.7	103.0	7.60	5.6	0.26	1.3	0.33	70	47	0.8	4600
S 3	26.5	30.5	2.2	86.0	7.50	6.0	0.16	0.6	0.30	10	44	0.2	240
S 4	29.5	32.0	1.0	61.0	7.10	5.4	0.27	1.1	0.24	3	26	0.1	460
S 5	25.5	30.5	2.4	70.0	7.50	6.0	0.35	0.8	0.43	98	41	0.2	4600
S 6	26.0	32.0	1.1	67.0	6.90	5.9	0.36	2.1	0.14	13	33	0.2	930
S 7	27.5	31.0	2.1	92.0	7.60	5.8	0.19	2.0	0.37	6	43	0.2	4600
S 8	23.8	24.5	1.6	97.0	7.60	6.2	0.26	1.4	0.12	0	50	0.2	4600

N = Non detected

APPENDIX F

ORDER COLEOPTERA

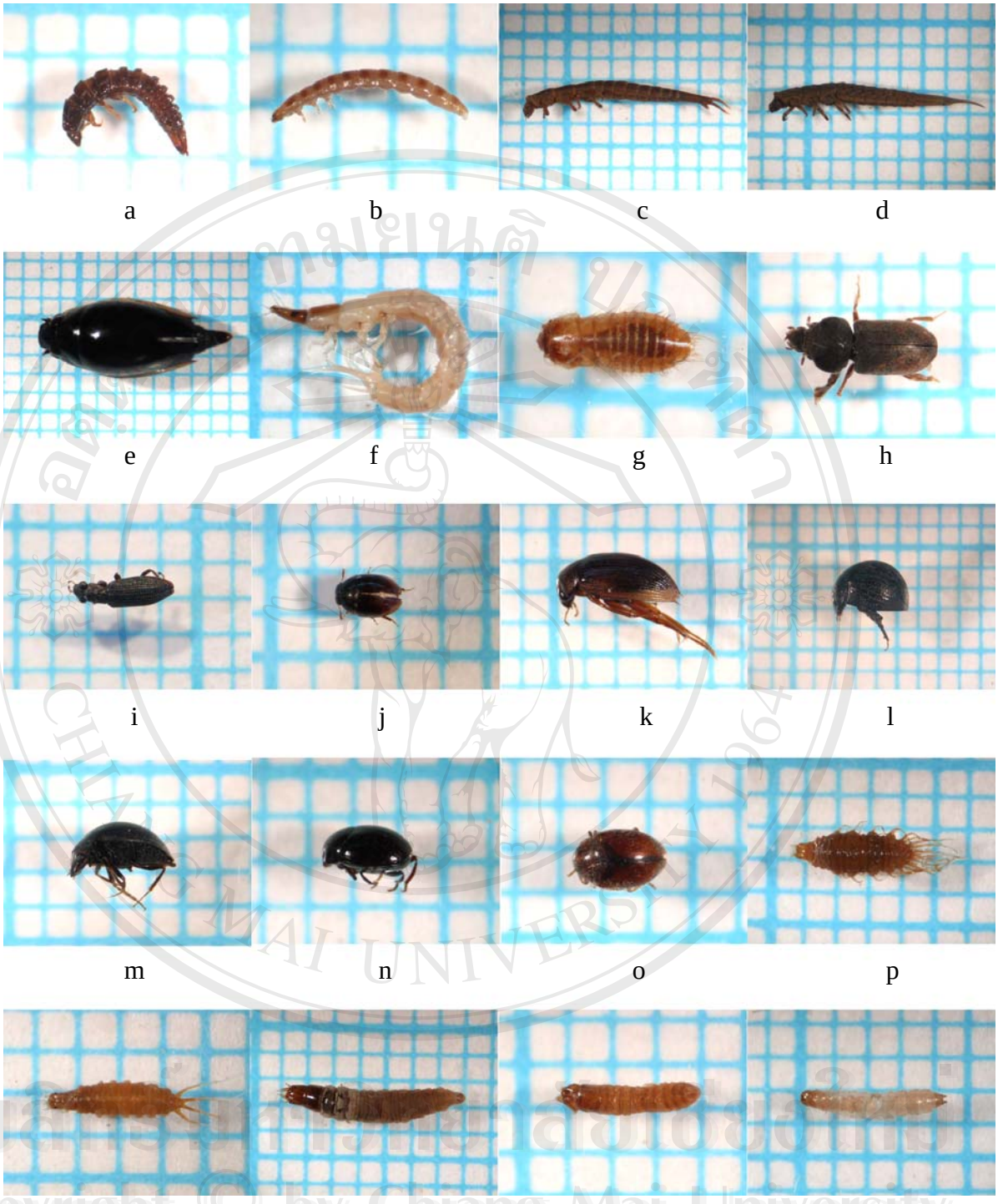


Note : 1 scale = 1 mm.

Figure 6-1 Families of aquatic insects were found in Mae Kham watershed:

a. Amphizoidae L1; b. Anthicidae L1; c. Dryopidae A1; d. Dryopidae A2; e. Dryopidae A3; f. Dryopidae L1; g. Dytiscidae A1; h. Dytiscidae A2; i. Dytiscidae A3; j. Dytiscidae A4; k. Dytiscidae A5; l. Dytiscidae L1; m. Dytiscidae L2; n. Dytiscidae L3; o. Elmidae A1 ; p. Elmidae A2; q. Elmidae A3; r. Elmidae A4; s. Elmidae A5; t. Elmidae L1

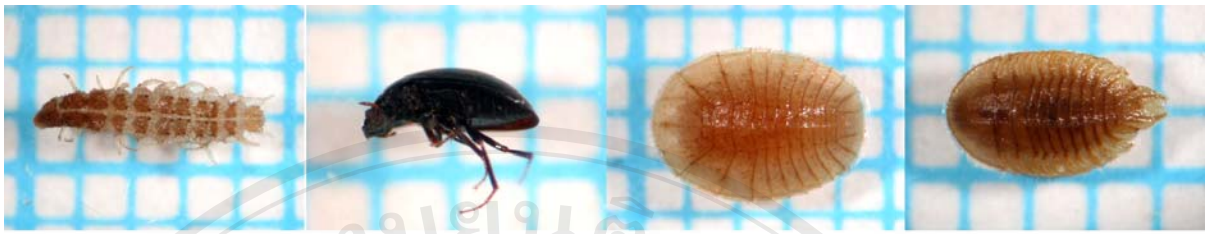
ORDER COLEOPTERA (CONTINUED)



Note : 1 scale = 1 mm.

Figure 6-2 Families of aquatic insects were found in Mae Kham watershed:
a. Elmidae L2; b. Elmidae L3; c. Elmidae L4; d. Elmidae L5; e. Gyrinidae A1; f. Gyrinidae L1; g. Helodidae L1; h. Heteroceridae A1; i. Hydrophilidae A1; j. Hydrophilidae A2; k. Hydrophilidae A3;l. Hydrophilidae A4; m. Hydrophilidae A5; n. Hydrophilidae A6;o. Hydrophilidae A7; p. Hydrophilidae L1; q. Hydrophilidae L2; r. Hydrophilidae L3; s. Hydrophilidae L4; t. Hydrophilidae L5

ORDER COLEOPTERA (CONTINUED)



a b c d

e f

ORDER COLLEMBORA

g h

ORDER DIPTERA

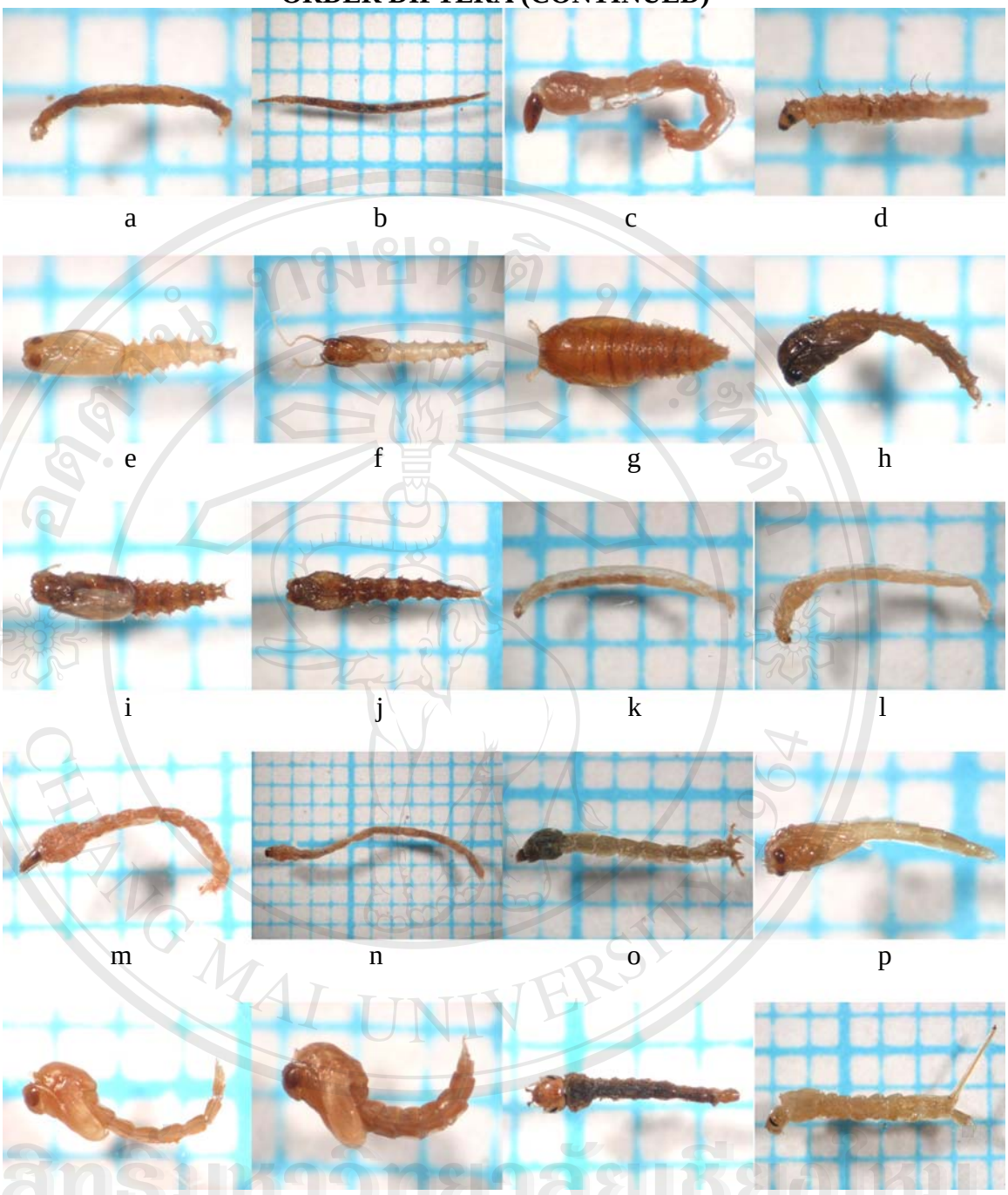
i j k l

Note : 1 scale = 1 mm.

Figure 6-3 Families of aquatic insects were found in Mae Kham watershed:

a. Lampypidae L1; b. Noteridae A1; c. Psephenidae L1; d. Psephenidae L2; e. Staphylinidae L1; f. Staphylinidae A1; g. Entomobryidae 1; h. Isotomidae 1; i. Athericidae L1; j. Athericidae L2; k.Ceratopogonidae L1; l.Ceratopogonidae L2

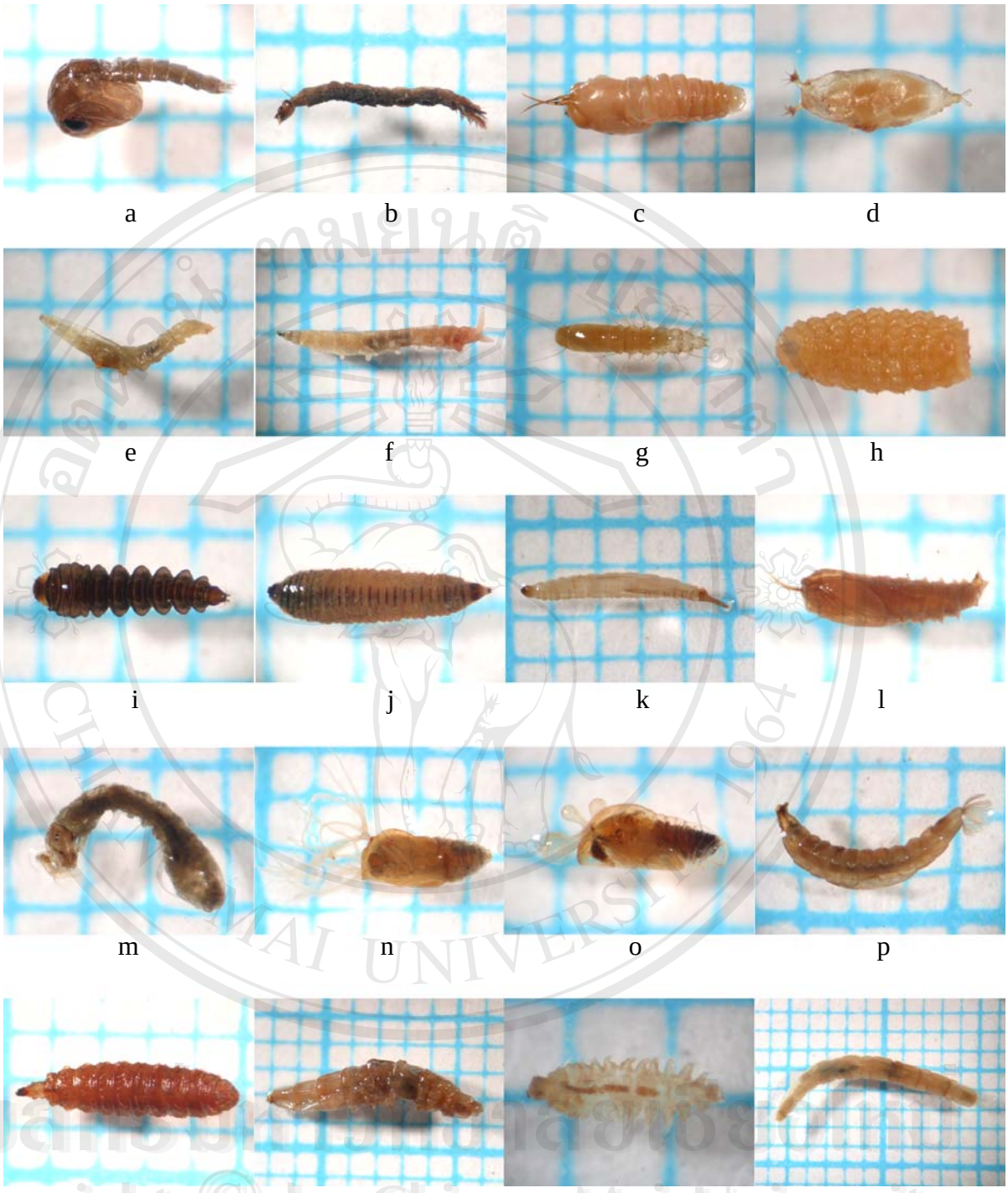
ORDER DIPTERA (CONTINUED)



Note : 1 scale = 1 mm.

Figure 6-4 Families of aquatic insects were found in Mae Kham watershed: a. Ceratopogonidae L3; b. Ceratopogonidae L4; c. Ceratopogonidae L5; d. Ceratopogonidae L6; e. Ceratopogonidae P1; f. Ceratopogonidae P2; g. Ceratopogonidae P3; h. Ceratopogonidae P4; i. Ceratopogonidae P5; j. Ceratopogonidae P6; k. Chironomidae L1; l. Chironomidae L2; m. Chironomidae L3; n. Chironomidae L4; o. Chironomidae L5; p. Chironomidae P1; q. Chironomidae P2; r. Chironomidae P3; s.Culicidae L1; t. Culicidae L2

ORDER DIPTERA (CONTINUED)

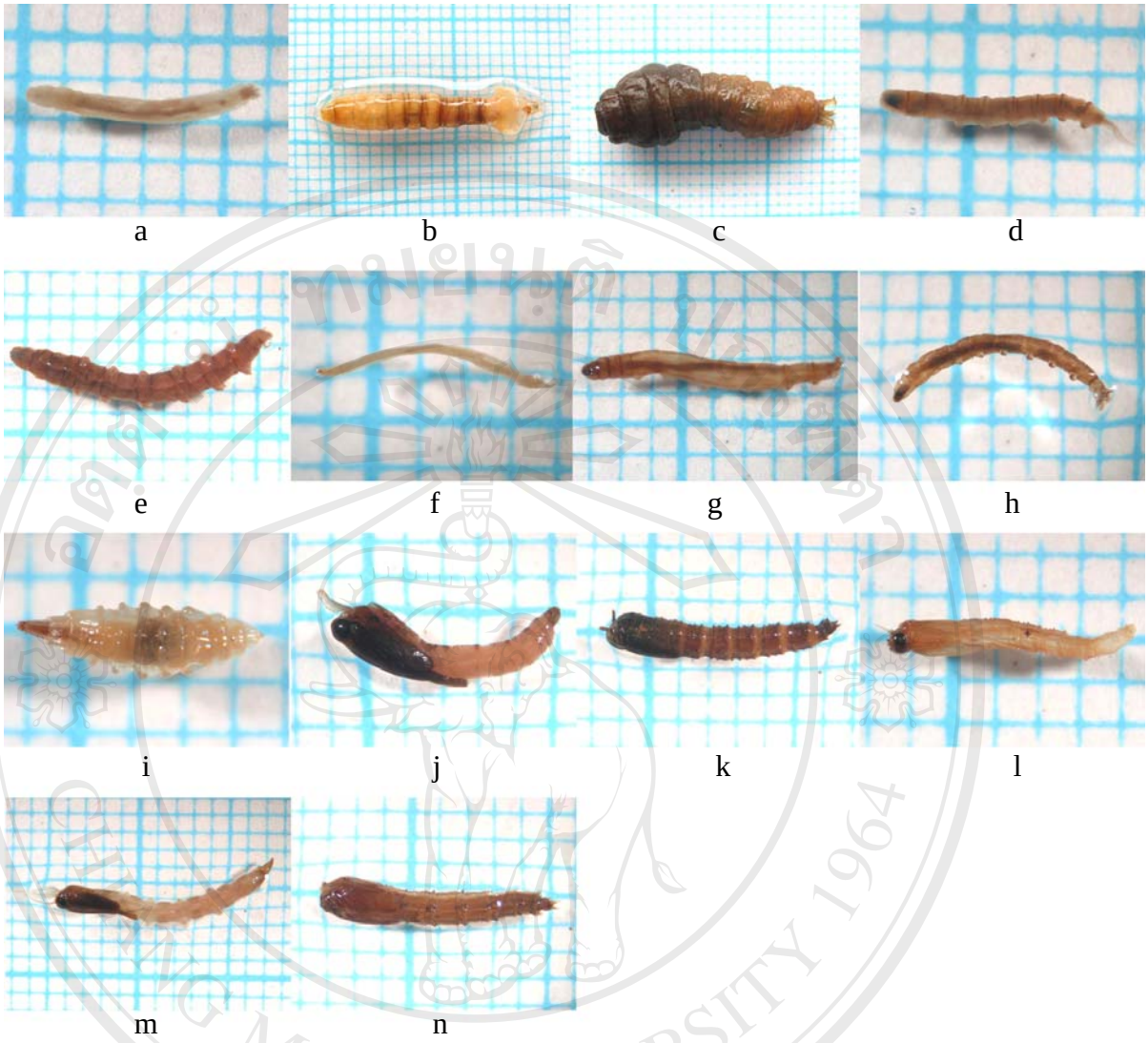


Note : 1 scale = 1 mm.

Figure 6-5 Families of aquatic insects were found in Mae Kham watershed:

a. Culicidae P1; b. Dixidae L1; c. Dolichopodidae P1; d. Drosophilidae P1; e. Empididae L1; f. Empididae L2; g. Empididae P1; h. Phoridae L1; i. Psychodidae L1; j. Psychodidae L2; k. Psychodidae L3; l. Psychodidae P1; m. Simuliidae L1; n. Simuliidae P1; o. Simuliidae P2; p. Stratiomidae L1; q. Stratiomidae L2; r. Tabanidae L1; s. Thaumaleidae L1; t. Tipulidae L1

ORDER DIPTERA (CONTINUED)



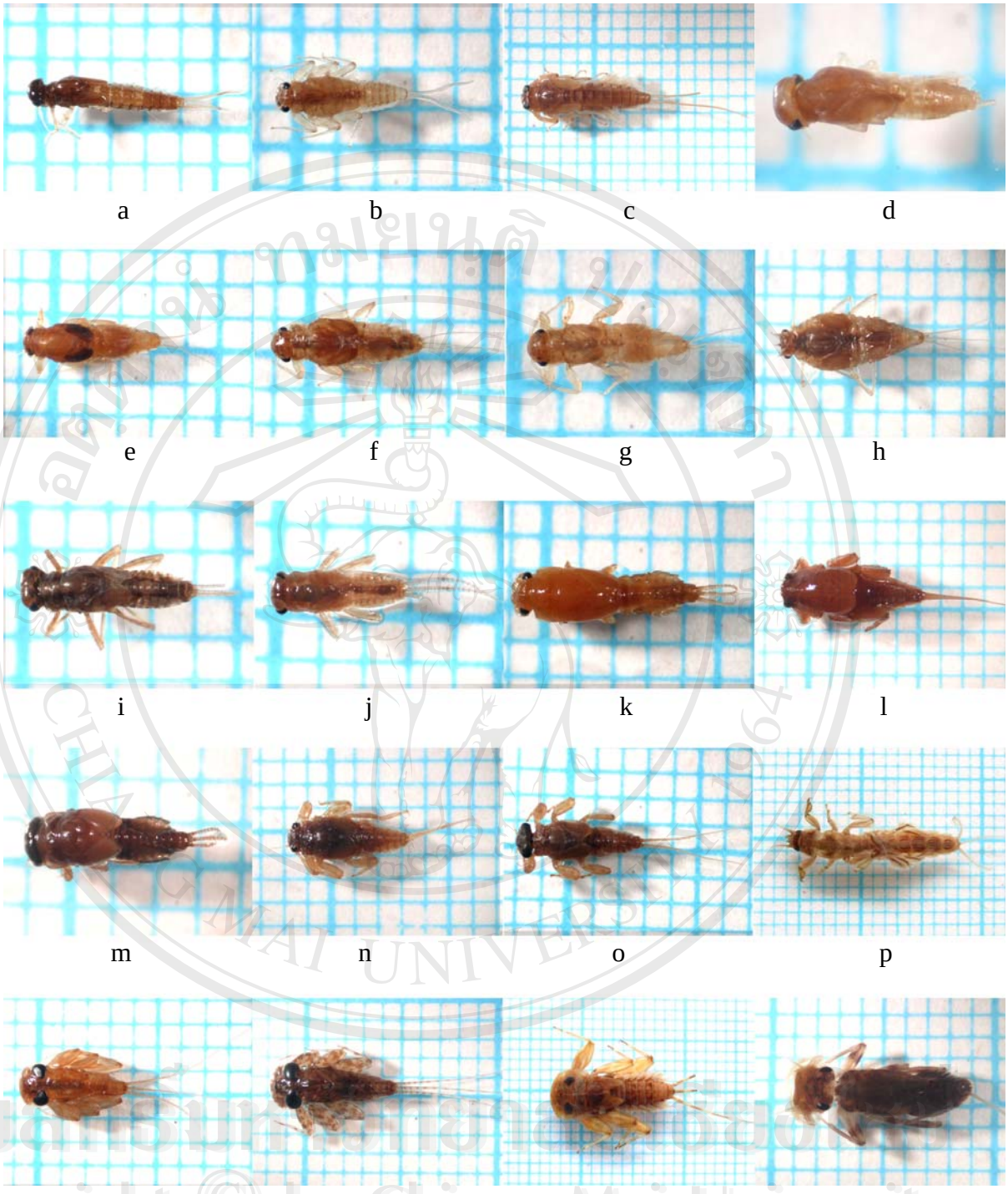
ORDER EPHEMEROPTERA

Note : 1 scale = 1 mm.

Figure 6-6 Families of aquatic insects were found in Mae Kham watershed:

a. Tipulidae L2; b. Tipulidae L3; c. Tipulidae L4; d. Tipulidae L5; e. Tipulidae L6; f. Tipulidae L7; g. Tipulidae L8; h. Tipulidae L9; i. Tipulidae L10; j. Tipulidae P1; k. Tipulidae P2; l. Tipulidae P3; m. Tipulidae P4; n. Tipulidae P5; o. Baetidae 1; p. Baetidae 2; q. Baetidae 3; r. Baetidae 4

ORDER EPHEMEROPTERA (CONTINUED)

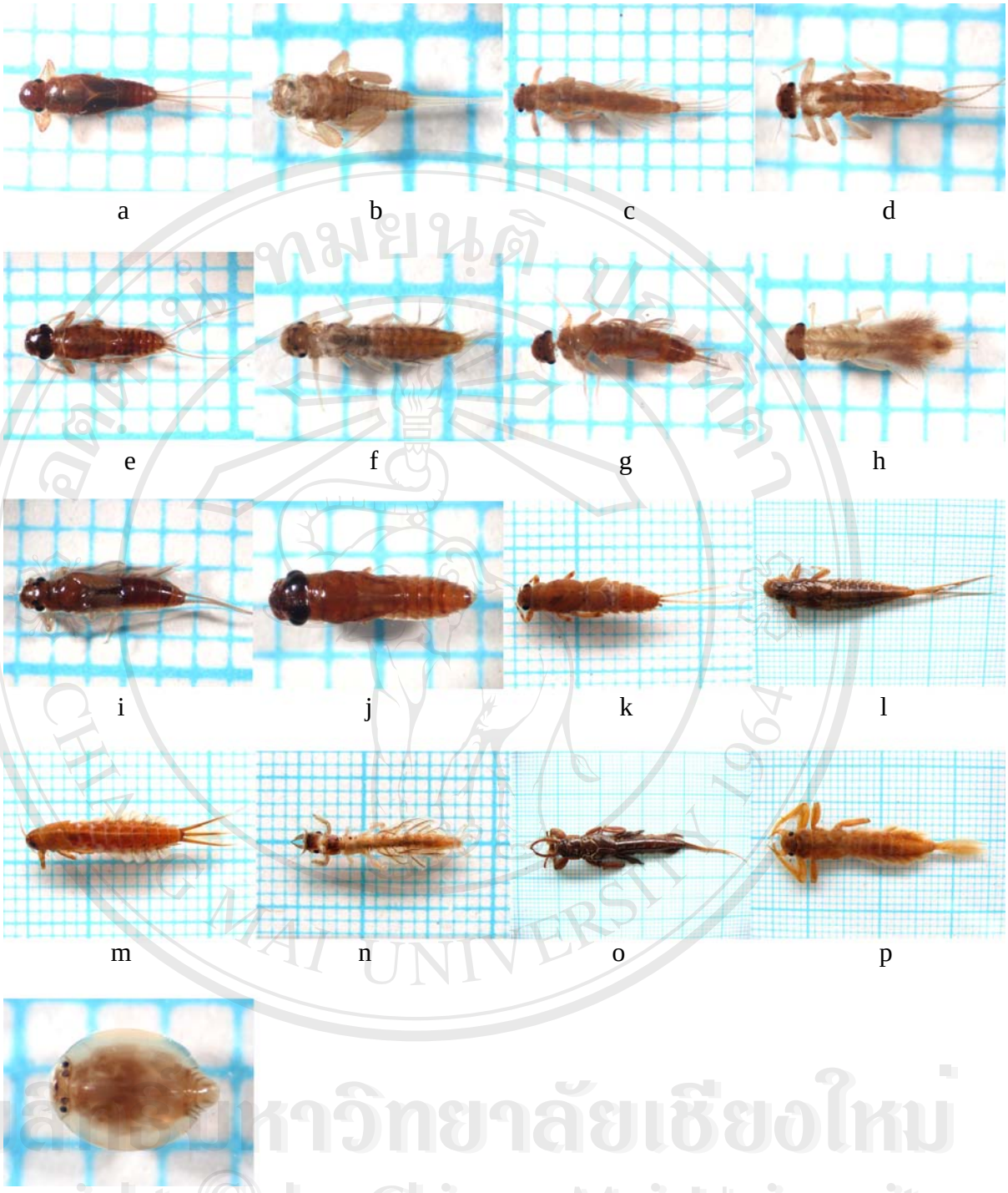


Note : 1 scale = 1 mm.

Figure 6-7 Families of aquatic insects were found in Mae Kham watershed:

a. Baetidae 5; b. Baetidae 6; c. Baetidae 7; d. Baetidae 8; e. Caenidae 1; f. Caenidae 2; g Caenidae 3; h. Caenidae 4; i. Ephemerellidae 1; j. Ephemerellidae 2; k. Ephemerellidae 3; l. Ephemerellidae 4; m. Ephemerellidae 5; n. Ephemerellidae 6; o. Ephemerellidae 7; p. Ephemeridae 1; q. Heptageniidae 1; r. Heptageniidae 2; s. Heptageniidae 3; t. Leptophlebiidae 1

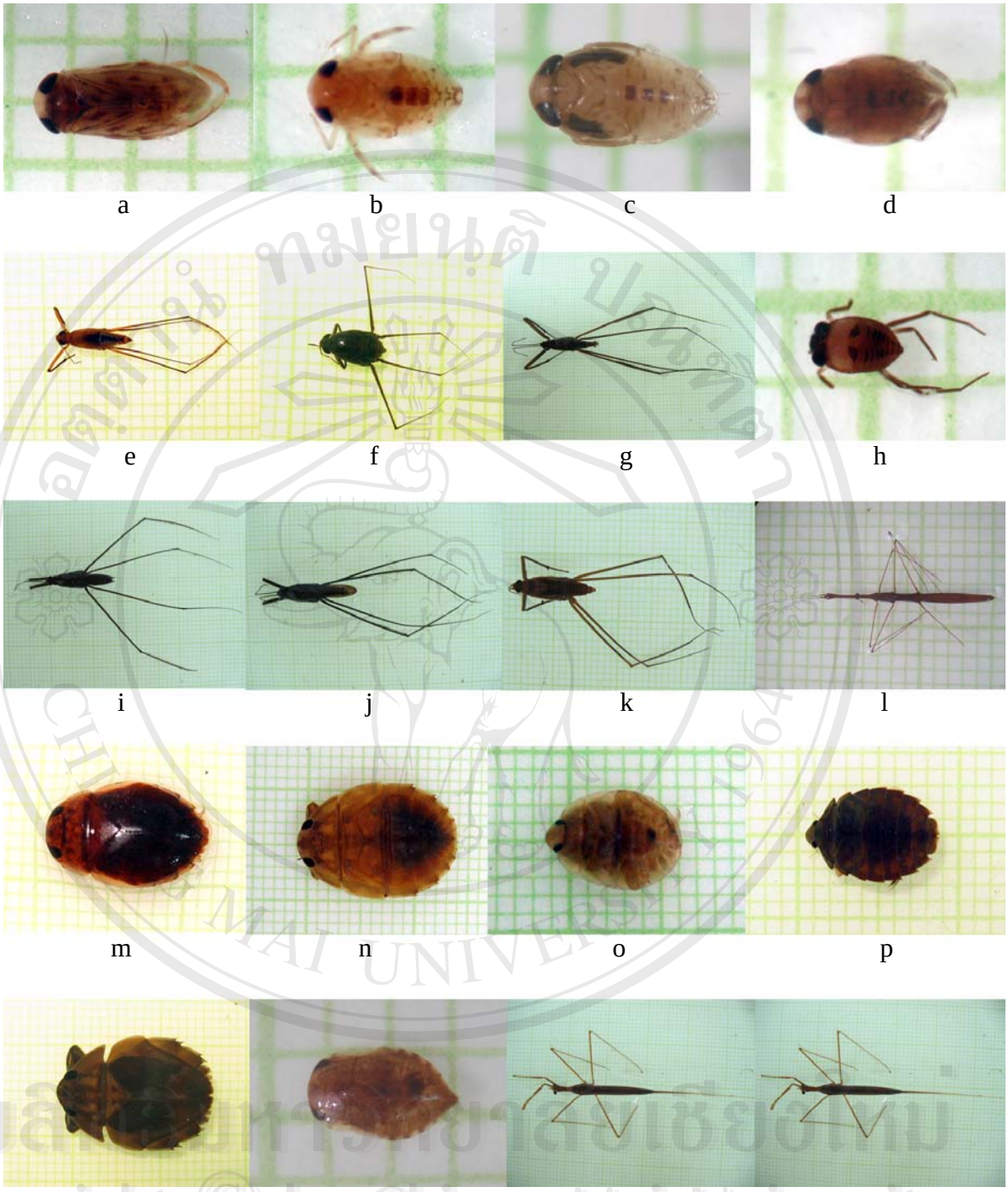
ORDER EPHEMEROPTERA (CONTINUED)



Note : 1 scale = 1 mm.

Figure 6-8 Families of aquatic insects were found in Mae Kham watershed:
a. Leptophlebiidae 2; b. Leptophlebiidae 3; c. Leptophlebiidae 4; d. Leptophlebiidae 5; e. Leptophlebiidae 6; f. Leptophlebiidae 7; g. Leptophlebiidae 8; h. Leptophlebiidae 9; i. Leptophlebiidae 10; j. Leptophlebiidae 11; k. Neoephemeridae 1; l. Oligoneuriidae 1; m. Oligoneuriidae 2; n. Polymitarcyidae 1; o. Polymitarcyidae 2; p. Potamanthidae 1; q. Prosopistomatidae 1

ORDER HEMIPTERA

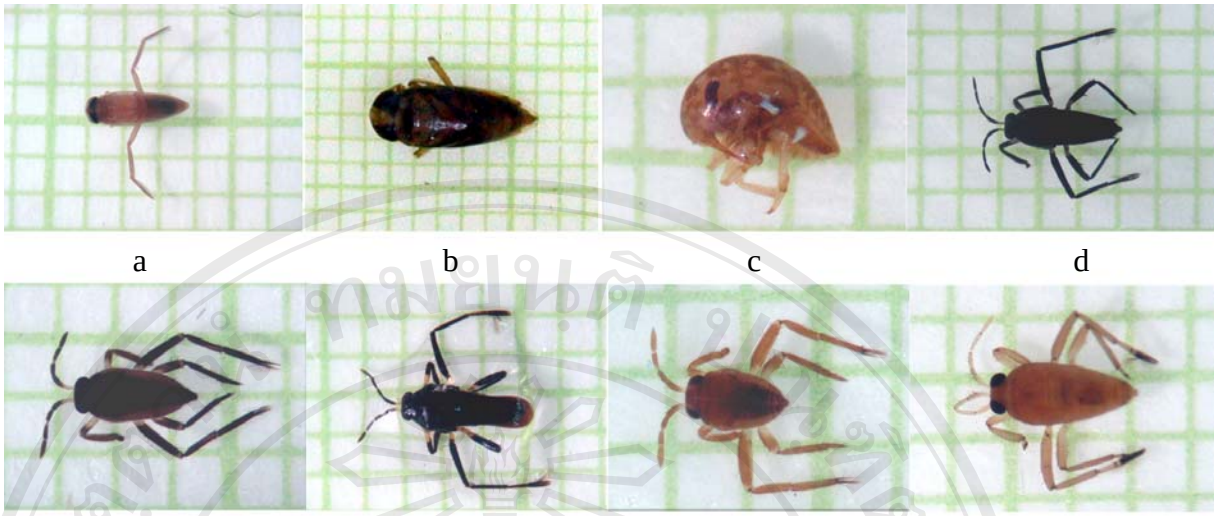


Note : 1 scale = 1 mm.

Figure 6-9 Families of aquatic insects were found in Mae Kham watershed:

a. Corixidae 1; b. Corixidae 2; c. Corixidae 3; d. Corixidae 4; e. Gerridae 1; f. Gerridae 2; g. Gerridae 3; h. Gerridae 4; i. Gerridae 5; j. Gerridae 6; k. Gerridae 7; l. Hydrometridae 1; m. Naucoridae 1; n. Naucoridae 2; o. Naucoridae 3; p. Naucoridae 4; q .Naucoridae 5; r. Naucoridae 6; s. Nepidae 1; t. Nepidae 2

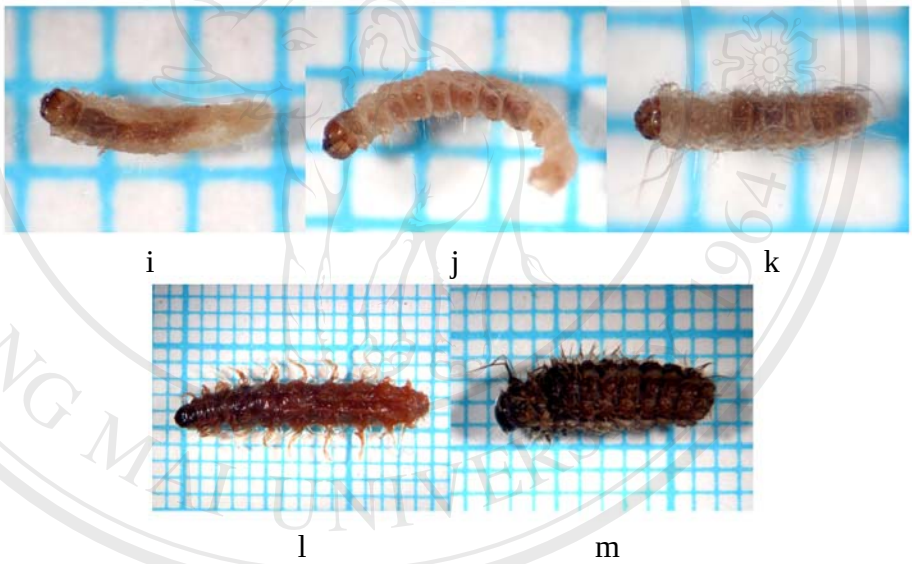
ORDER HEMIPTERA (CONTINUED)



a b c d

e f g h

ORDER LEPIDOPTERA



i j k

l m

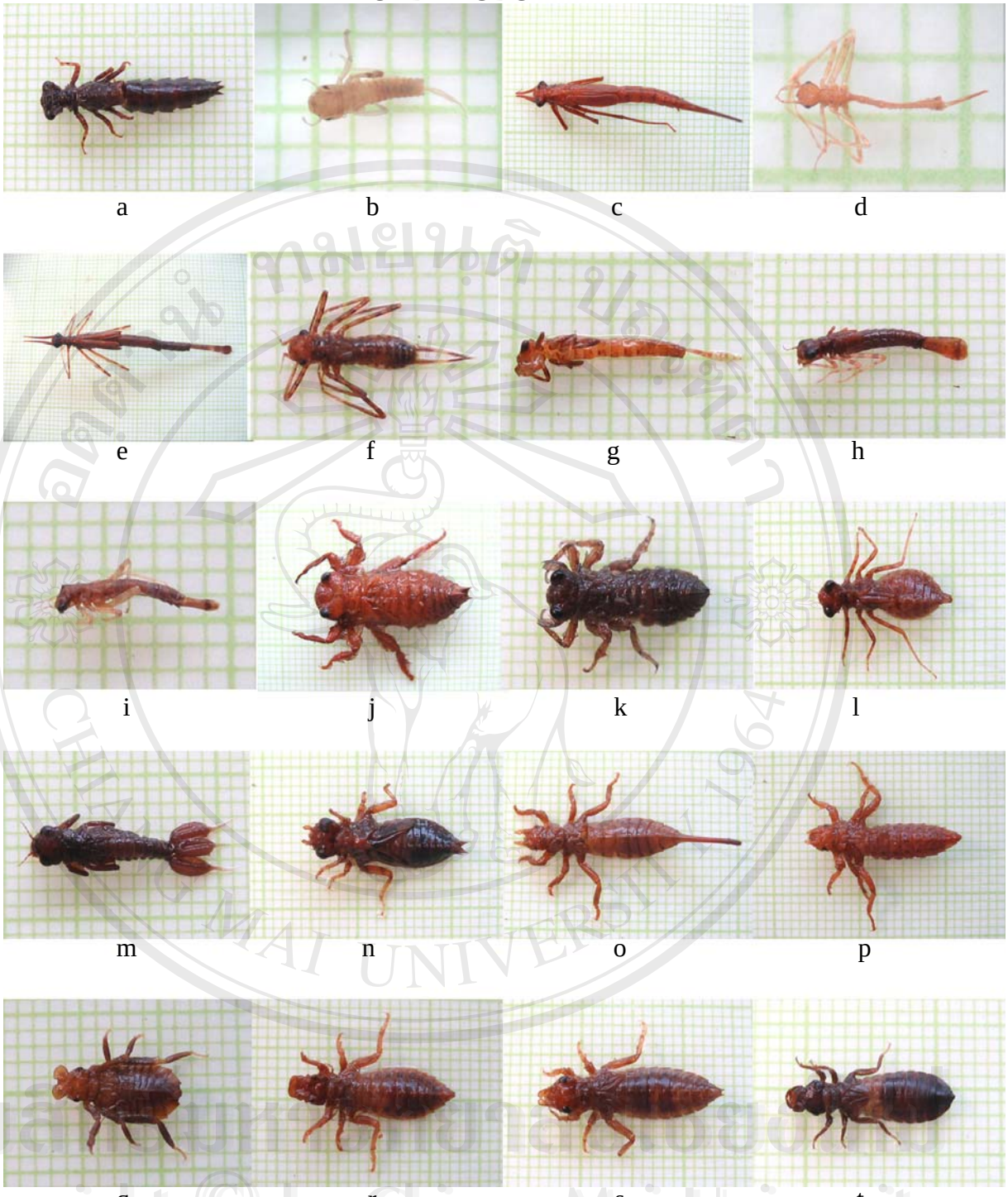
ORDER MEGALOPTERA

n o

Note : 1 scale = 1 mm.

Figure 6-10 Families of aquatic insects were found in Mae Kham watershed:
a. Notonectidae 1; b. Notonectidae 2; c. Pleidae 1; d. Veliidae 1; e. Veliidae 2; f. Veliidae 3; g. Veliidae 4; h. Veliidae 5; i. Pyralidae L1; j. Pyralidae L2; k. Pyralidae L3; l.Pyralidae L4; m. Pyralidae L5; n. Corydalidae 1; o. Sialidae 1

ORDER ODONATA

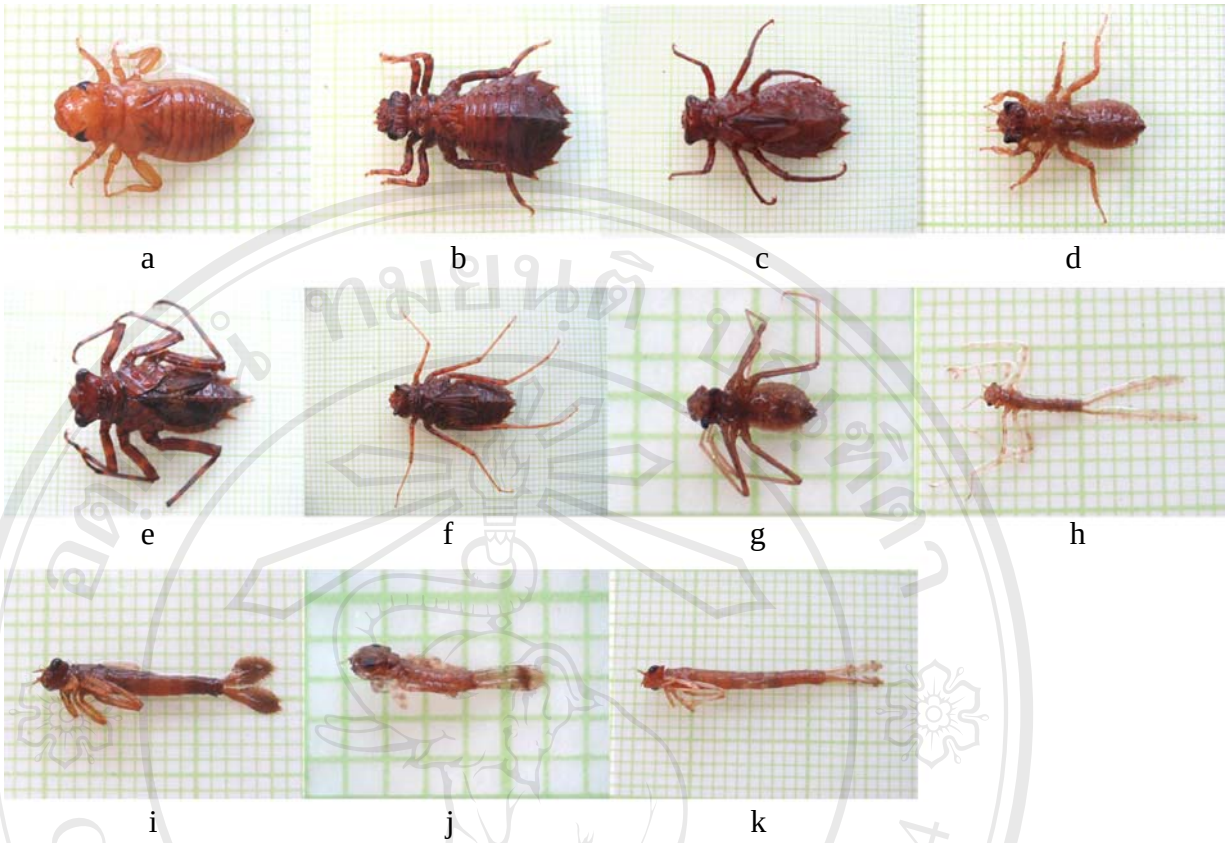


Note : 1 scale = 1 mm.

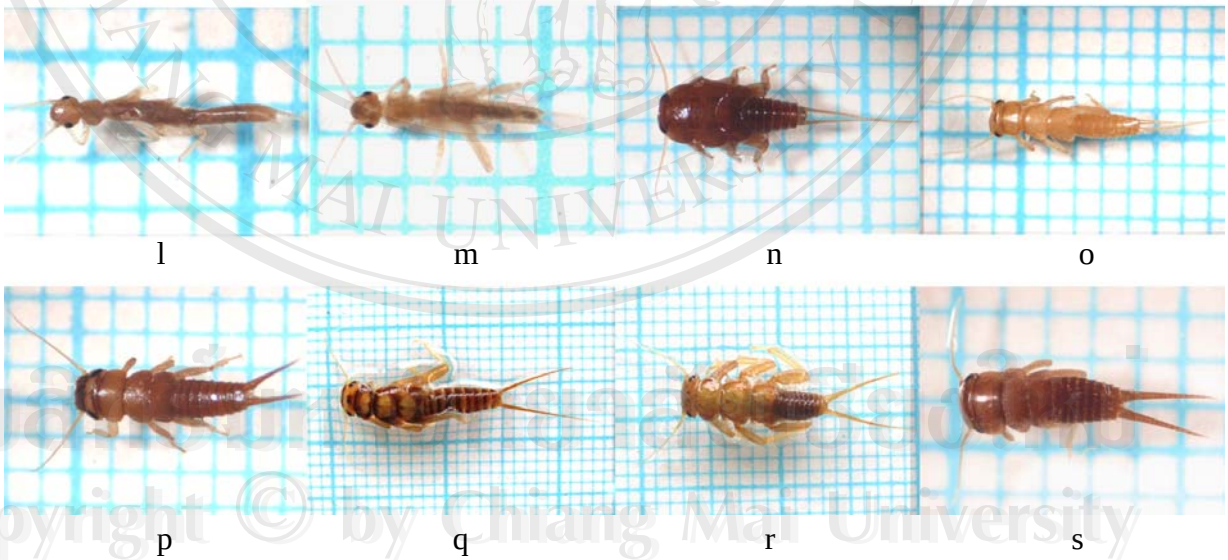
Figure 6-11 Families of aquatic insects were found in Mae Kham watershed:

a. Aeshnidae 1; b.Amphipterygidae 1; c.Calopterygidae 1; d.Calopterygidae 2; e. Calopterygidae 3; f. Chlorocyphidae 1; g. Coenagrionidae 1; h. Coenagrionidae 2; i. Coenagrionidae 3; j. Cordulegustridae 1; k. Cordulegustridae 2; l. Corduliidae 1; m. Euphaeidae 1; n. Gomphidae 1; o. Gomphidae 2; p. Gomphidae 3; q. Gomphidae 4; r. Gomphidae 5; s. Gomphidae 6; t. Gomphidae 7

ORDER ODONATA (CONTINUED)



ORDER PLECOPTERA



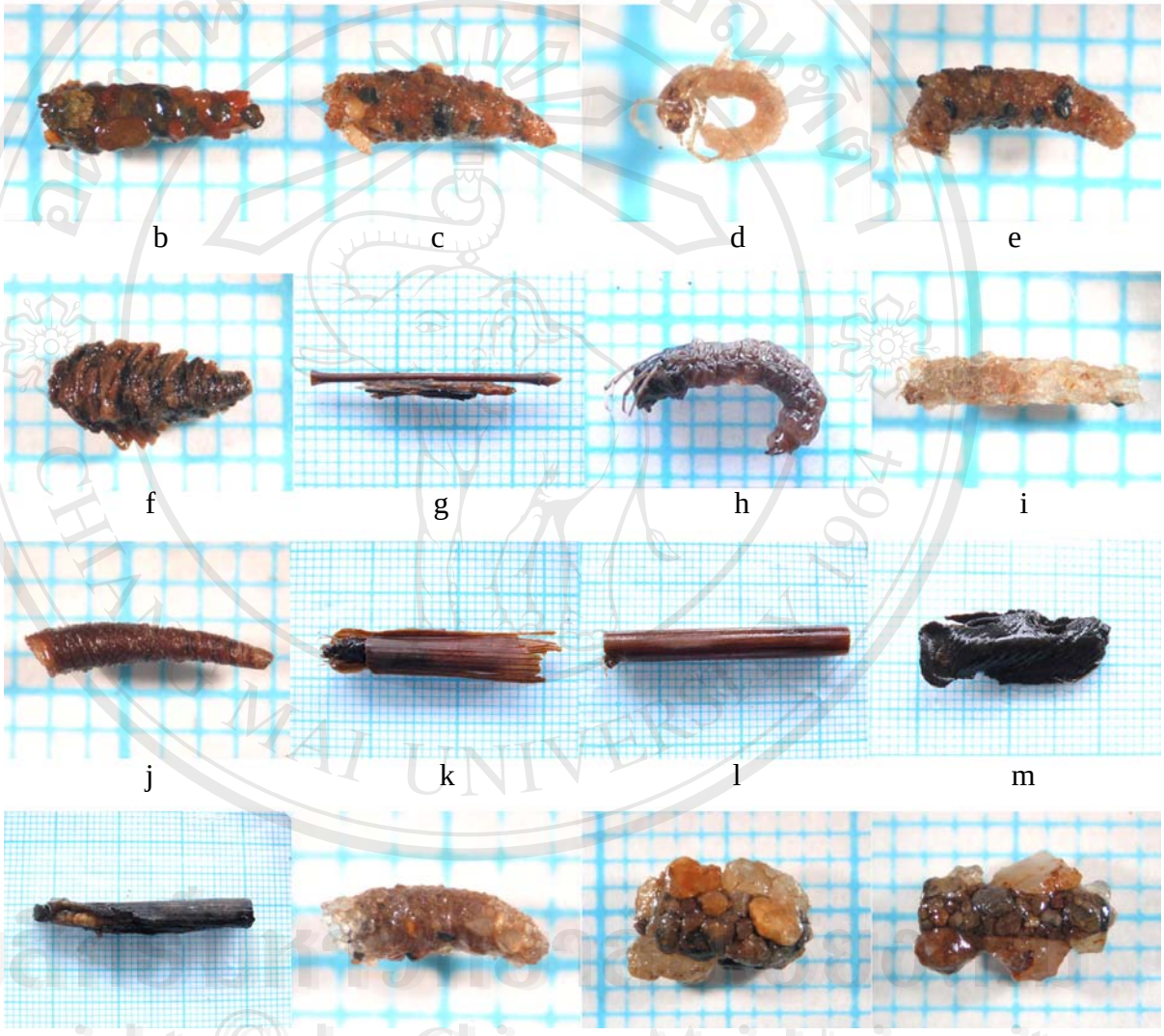
Note : 1 scale = 1 mm.

Figure 6-12 Families of aquatic insects were found in Mae Kham watershed: a. Gomphidae 8; b. Gomphidae 9; c. Libellulidae 1; d. Libellulidae 2; e. Libellulidae 3; f. Macromiidae 1; g. Macromiidae 2; h. Platycnemididae 1; i. Platystictidae 1; j. Platystictidae 2; k. Protonneuridae 1; l. Leuctridae 1; m. Nemouridae 1; n. Peltoperlidae 1; o. Perlidae 1; p. Perlidae 2; q. Perlidae 3; r. Perlidae 4; s. Perlidae 5

ORDER PLECOPTERA (CONTINUED)

a

ORDER TRICHOPTERA



b c d e

f g h i

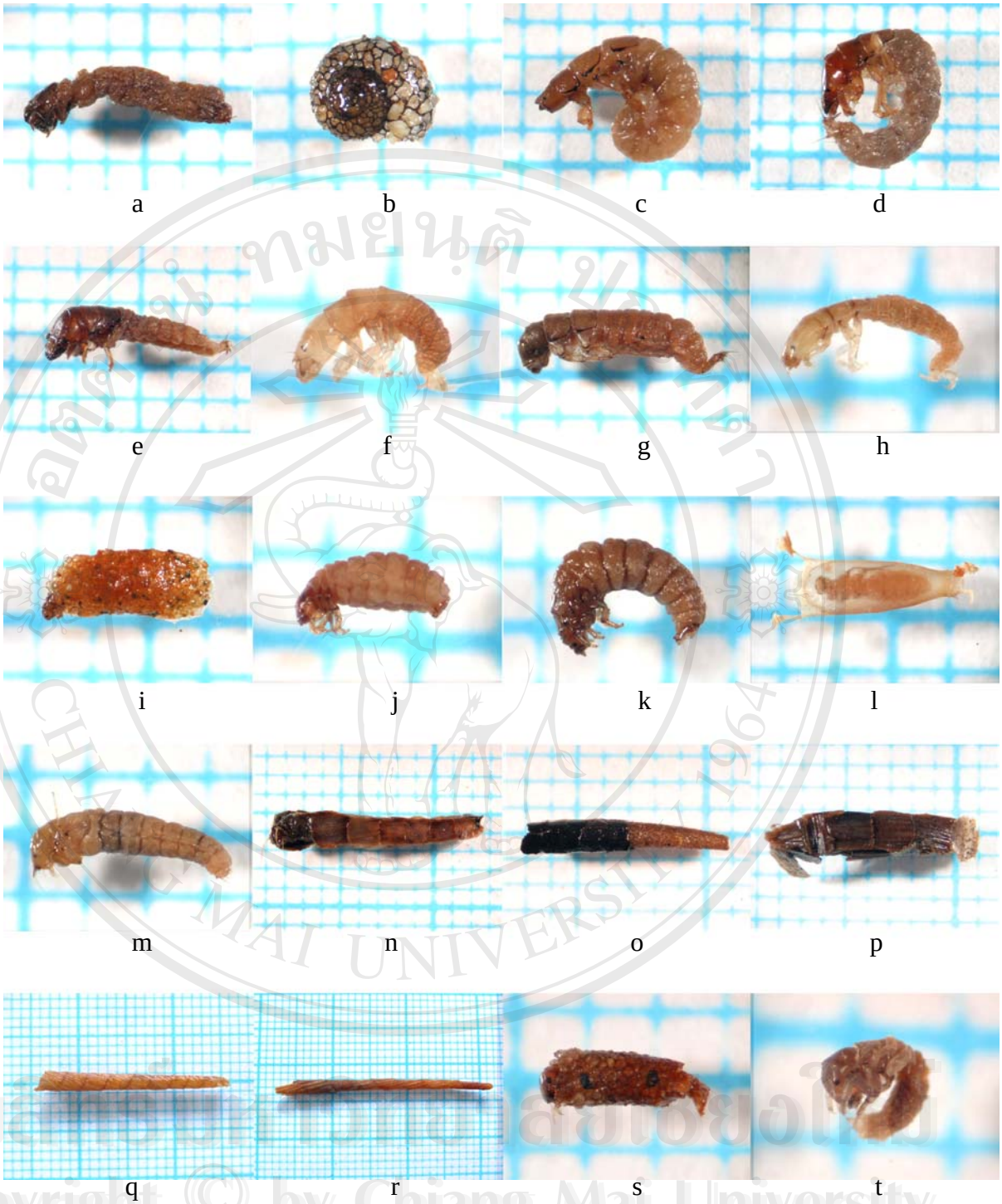
j k l m

n o p q

Note : 1 scale = 1 mm.

Figure 6-13 Families of aquatic insects were found in Mae Kham watershed:
a. Taeniopterygidae 1; b. Apataniidae 1; c. Apataniidae 2; d. Apataniidae 3; e. Apataniidae 4; f. Apataniidae 5; g. Apataniidae 6 ; h. Apataniidae 8; i. Brachycentridae 1; j. Brachycentridae 2; k. Calamoceratidae 1; l. Calamoceratidae 2; m. Calamoceratidae P1; n. Calamoceratidae P2; o. Glossosomatidae 1; p. Goeridae 1; q. Goeridae 2

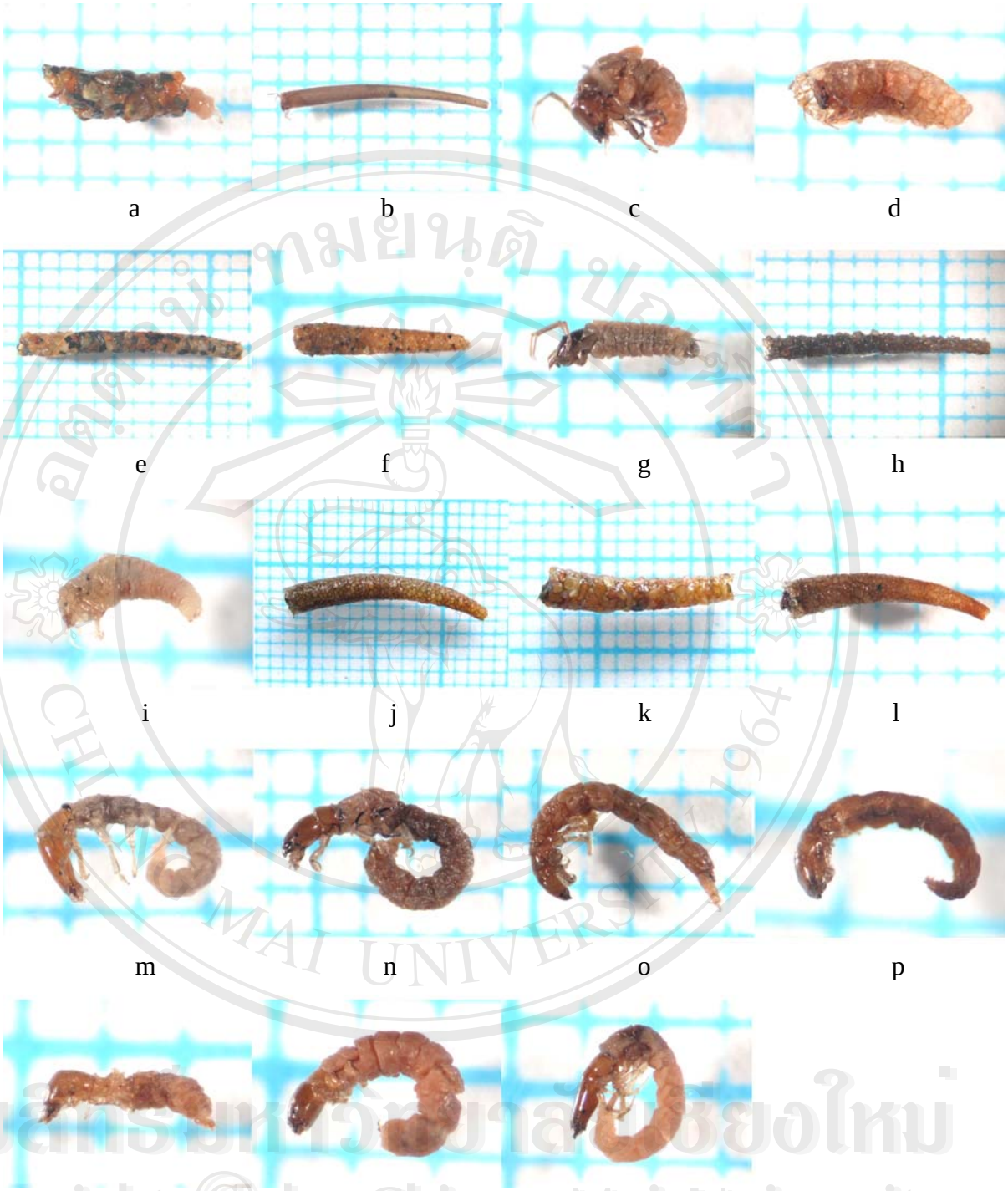
ORDER TRICHOPTERA (CONTINUED)



Note : 1 scale = 1 mm.

Figure 6-14 Families of aquatic insects were found in Mae Kham watershed:
a. Goeridae 3; b. Helicopsychidae ; c. Hydropsychidae 1; d. Hydropsychidae 2; e. Hydropsychidae 3; f. Hydropsychidae 4; g. Hydropsychidae 5; h. Hydroptilidae 1 ; i. Hydroptilidae 2; j. Hydroptilidae 3 ; k.Hydroptilidae 4; l. Hydroptilidae P1 ; m. Lepidostomatidae 1; n. Lepidostomatidae 2; o. Lepidostomatidae 3; p. Lepidostomatidae P1; q. Leptoceridae 1; r. Leptoceridae 2; s. Leptoceridae 3; t. Leptoceridae 4

ORDER TRICHOPTERA (CONTINUED)



Note : 1 scale = 1 mm.

Figure 6-15 Families of aquatic insects were found in Mae Kham watershed:
a. Leptoceridae 5; b. Leptoceridae 6; c. Leptoceridae 7; d. Leptoceridae 8; e. Leptoceridae 9; f. Leptoceridae 10; g. Leptoceridae 11; h. Leptoceridae 12; i.Odontoceridae 1; j. Odontoceridae 2; k. Odontoceridae 3; l. Odontoceridae 4; m. Philopotamidae 1; n. Polycentropodidae 1; o. Polycentropodidae 2; p. Polycentropodidae 3; q. Psychomyiidae 1; r. Psychomyiidae 2; s. Stenopsychidae 1

CURRICULUM VITAE

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