

CHAPTER 5

DISCUSSION

5.1 Taxonomy

This study revealed 11 species, 2 subspecies, 6 genera, and 3 families of proturans from 5 study sites within an altitudinal gradient of 700 meters to 2450 meters in the Doi Inthanon National Park, Chiang Mai province, Thailand. These proturan species were found belonging to the genera *Condeellum* Tuxen (2 spp.), *Australentulus* Tuxen (1 sp.), *Silvestridia* Bonet (1 sp.), *Baculentulus* Tuxen, 1977 (1 sp.), *Kenyentulus* Tuxen (2 spp.), and *Eosentomon* Berlese (4 spp.).

The 11 species consisted of 3 described species (*Condeellum regale* Condé, *C. ishiiianum ishiiianum* Imadaté, *Silvestridia keijiana* (Imadaté)), including one subspecies *C. ishiiianum setosum* Imadaté newly recorded for Thailand, and 8 undescribed species (*Australentulus* sp., *Baculentulus* sp., *Kenyentulus* sp. 1, *Kenyentulus* sp. 2, *Eosentomon* sp. 1, *Eosentomon* sp. 2, *Eosentomon* sp. 3, and *Eosentomon* sp. 4).

For the genus *Condeellum*, 2 species and 2 subspecies *Condeellum regale* (Condé), *C. ishiiianum ishiiianum* Imadaté, and *C. ishiiianum setosum* Imadaté were found newly recorded in Thailand.

Condeellum regale (Condé) and *C. ishiiianum ishiiianum* Imadaté, were found on Doi Suthep-Pui, Chiang Mai province then again in the Doi Inthanon National Park, Chiang Mai province, near Doi Suthep-pui. The descriptions of these species are no different from the original descriptions (Imadaté, 1965; Likhitrikarn, 2004).

Condeellum ishiiianum setosum Imadaté, A newly recorded subspecies, is similar to *C. ishiiianum ishiiianum* (Condé), except for the presence of anterior setae (A1) on urotergite VII and the presence of 1a on urosternite IX (Imadaté, 1991). This species had previously been found in Borneo but is new to Thailand.

Australentulus sp. was found in genus *Australentulus*. The body length is much greater when compared to the body length of all other proturan species in this study. It was similar to *Australentulus prachedee* Imadaté which has been found in Thailand but distinct in the absence of anterior setae (A4) on urotergite V and the length of sensillum *c* (Imadaté, 1965, 1989).

One species *Silvestridia keijiana* (Imadaté) was found in genus *Silvestridia*. It is similar to the original description which had been previously known from Thailand (Imadaté, 1965).

The first time Imadaté (1965) published a description of *Bereberentulus* spp. was before Tuxen (1976) announced the new genus *Baculentulus*. All species in genus *Bereberentulus* which were found at that time, were changed to genus *Baculentulus*. Most characteristics of genus *Baculentulus* were similar to genus *Bereberentulus* but can be differentiated based on the sensillum *t-1* of *Bereberentulus* is claviform and in *Baculentulus* it is baculiform. This species, *Baculentulus* sp., is similar to *Baculentulus umesaoi* (Imadaté, 1965) but it is distinct in chaetotaxy of urotergites IX-X and the length of foretarsal sensilla *a*, *c*, *d*, and *e*.

In *Kenyentulus*, two species *Kenyentulus* sp. 1 and sp. 2. were found. *Kenyentulus* sp. 1 was similar to *Kenyentulus malaysiensis* (Imadaté, 1965) on the foretarsal sensillum *b'* at the same level with *t-2* and urotergite V-VI, with two pairs of anterior setae (A2, 5) but it is distinct in the length of foretarsal sensilla *a*, *e*, *f*.

Kenyentulus sp. 2 was similar to *Kenyentulus* sp. 1 but *Kenyentulus* sp. 2 was distinct in urotergite IV possessing two pairs of anterior setae (A2, 5) while *Kenyentulus* sp. 1 had urotergite IV with three pairs of anterior setae (A1, 2, 5).

The last genus found was *Eosentomon*. This is a large genus with more than 280 described species (Szeptycki, 2003). It was difficult to find the descriptions and complicated to check the descriptions because proturan is a poorly known group like many groups of Acarina, Myriapoda, etc. and there are few specialists who study proturan (Szeptycki, 2002). However, four species could be distinguished from the specimens collected. They were unlike the species previously known from Thailand (Imadaté, 1965; Likhitrikarn, 2004).

In 1965, Imadaté reported 25 species, 7 genera, and 3 families of proturans found throughout Thailand (Imadaté and Kira, 1964). Later, Likhitrikarn (2004) conducted a survey in the Doi Suthep-Pui National Park, Chiang Mai province, Northern Thailand and found 11 species in 4 genera and 3 families. Three of the species were found to be new and are pending publication. Finally, this study found 11 species, 2 subspecies, 6 genera, and 3 families, one newly recorded in Thailand, and 8 undescribed species.

Until now, a total of 25 proturan species and 2 subspecies were known to occur in Thailand. These are low numbers of proturan species when compared with the described species, in 71 genera worldwide (Szeptycki, 2002). Europe has 166 species in 17 genera (Imadaté, 1989; Szeptycki, 2002). Austria is known to possess 32 species in 10 genera, and 3 families (Department of the Environment and Heritage, 2006; Tuxen, 1964). In Japan 68 species, 25 genera, and 4 families have been found (Imadaté, 1974; Nakamura, 2003). China has 156 species, 34 genera, and 10 families. In this study, 8 undescribed species were found. It is highly probable that these will be new species due to the lack of previous studies on proturan in Thailand and other Southeast Asia countries. Studies in these areas are always likely to discover new taxa. For example, Szeptycki and Imadaté (1987) conducted a study in Korea and found 11 species in 6 genera, 10 of them were new species and one new recording. Nakamura's (1997) studied in Taiwan found 10 species in 4 genera, 5 of which were new species. If we collect more specimens in Thailand, it is likely we will discover new species and possibly new genera as well. Therefore, the studies of proturan in Thailand should be continued and expanded.

5.2 Checklist of proturans in Thailand

Suborder **Acerentomoidea** Condé, 1951

Family **Protentomidae**, Ewing, 1936

Genus **Condeellum** Tuxen, 1963

Condeellum regale (Condé, 1958)

Condeellum ishiiianum ishiiianum Imadaté, 1965

Condeellum ishiiianum setosum Imadaté, 1991

Family **Acerentomidae** Silvestri, 1907

Genus **Australentulus** Tuxen, 1967

Australentulus prachedee (Imadaté, 1965)

Genus **Silvestridia** Bonet, 1942

Silvestridia keijiana (Imadaté, 1965)

Genus **Baculentulus** Tuxen, 1977

Baculentulus morikawai (Imadaté & Yosii, 1956)

Baculentulus duongkeoi (Imadaté, 1965)

Baculentulus bervinguis (Condé, 1961)

Baculentulus umesaoui (Imadaté, 1965)

Baculentulus matsuokai (Imadaté, 1965)

Baculentulus lanna (Imadaté, 1965)

Baculentulus ogawai (Imadaté, 1965)

Baculentulus oginoi (Imadaté, 1965)

Genus **Gracilentulus** Tuxen, 1963

Gracilentulus sachikoeae Imadaté, 1965

Genus **Kenyentulus** Tuxen, 1981

Kenyentulus ohyamai (Imadaté, 1965)

Suborder **Eosentomoidea** Condé, 1951

Family **Eosentomidae** Berlese, 1909

Genus ***Eosentomon*** Berlese, 1909

Eosentomon kloomi Imadaté, 1965

Eosentomon paktai Imadaté, 1965

Eosentomon thamnooni Imadaté, 1965

Eosentomon imbutum Imadaté, 1965

Eosentomon yanaka Imadaté, 1965

Eosentomon sawasdi Imadaté, 1965

Eosentomon sayani Imadaté, 1965

Eosentomon pairathi Imadaté, 1965

Eosentomon hyatti Condé, 1958

Eosentomon torbongsi Imadaté, 1965

Eosentomon udorni Imadaté, 1965

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5.3 Distribution

Table 14 shows the relationship between distribution of species found in Doi Inthanon National Park, Chiang Mai province.

Table 14 Altitudinal occurrences of proturan species found in the Doi Inthanon National Park, Chiang Mai province.

	Altitude				
	700 m	1000 m	1650 m	2100 m	2450 m
<i>Condeellum regale</i>	√				
<i>C. ishiiianum ishiiianum</i>	√		√		
<i>C. ishiiianum setosum</i>	√		√	√	
<i>Australentulus</i> sp.				√	
<i>Silvestridia keijiana</i>			√		
<i>Baculentulus</i> sp.			√		
<i>Kenyentulus</i> sp. 1	√				
<i>Kenyentulus</i> sp. 2	√				
<i>Eosentomon</i> sp. 1					√
<i>Eosentomon</i> sp. 2					√
<i>Eosentomon</i> sp. 3	√				√
<i>Eosentomon</i> sp. 4	√				√

Condeellum regale, is represented by only a single specimen found in bamboo stands at an elevation of 700 meters.

Condeellum ishiiianum ishiiianum and *C. ishiiianum setosum* were found in bamboo stands and an evergreen hill forest at 1650 meters elevation. These two species are very similar and difficult to identify.

Australentulus sp. was represented only in evergreen hill forests at 2100 meters.

Silvestridia keijiana and *Baculentulus* sp., were found only in evergreen hill forests at 1650 meters elevation. These species were dominant at this altitudinal site.

Kenyentulus spp. were found only in bamboo stands at 700 meters.

Eosentomon sp. 1 and sp. 2 are high altitude species that occurred only in evergreen hill forests at 2450 meters elevation.

Eosentomon sp. 4 occurred in evergreen hill forests at 2450 meters elevation, and was dominant at the higher elevations.

Table 14 shows that the highest number of proturan species were found at altitudes above 700 meters elevation to the summit; at altitudes around 1000 meters, proturans were not found at altitudes around 2100 meters, lower numbers of proturan species were found, and at altitudes of 2450 meters, only *Eosentomon* spp. were found.

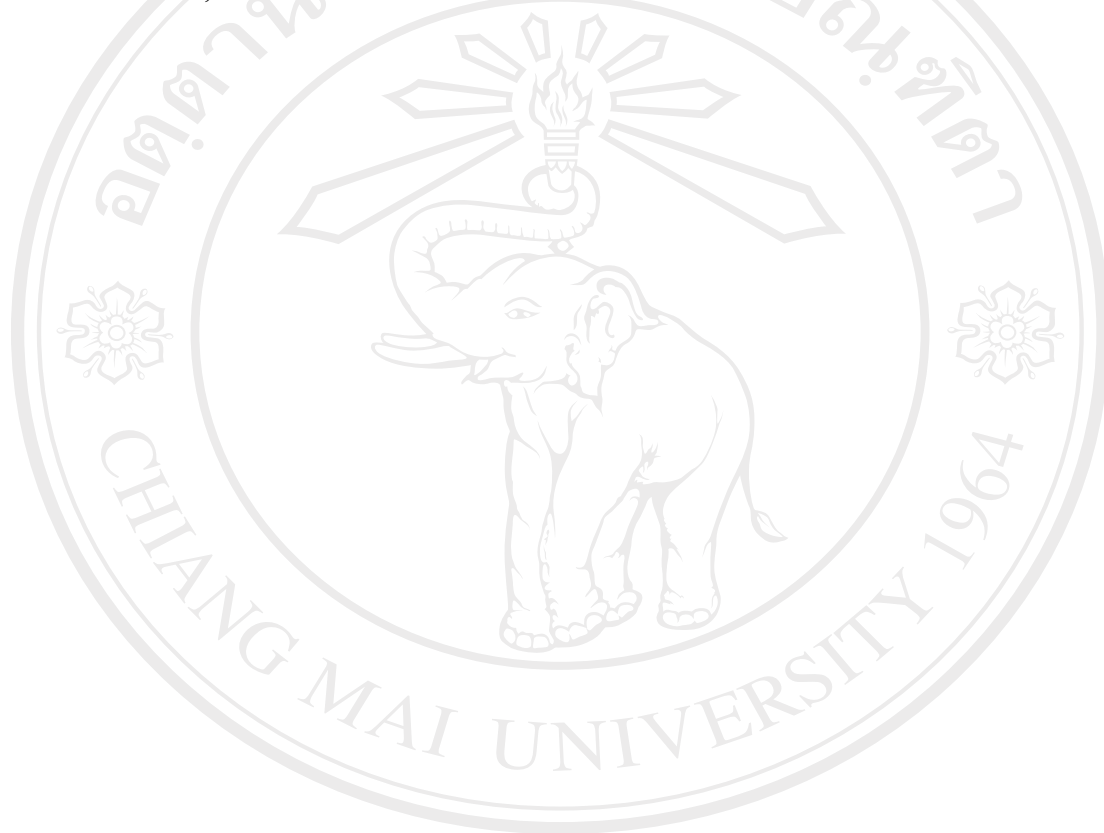
The main objective of this study was to study the taxonomy of proturan in Thailand. The finding of this research can be a basic guide for new researchers who wish to study proturan in Thailand and as an example of species description and keys because no study of this type presently exists.

5.4 Future research of proturan in Thailand

Despite many new discoveries, the number of known species remains insufficient. Even in the best known areas, for example Japan or Poland, new taxa are still being discovered. The 66 species recorded from Poland comprise about 60–70% of the species expected in this country. Probably only 10 % of the world fauna is known (Szeptycki, 2002). Therefore, the study of proturan should continue so that new proturan species can be described before the possible extinction of undiscovered species, due to environmental degradation and/or larger scale environmental changes, *i.e.*, global warming.

Normally, proturan studies will survey the forest soil but Christian and Szeptycki (2004) found proturans 42 species in urban Vienna. Moreover, it was a surprise when Lussenhop (1973) found proturans near a Chicago Expressway Margin. Therefore, you can collect specimens of proturan outside of forest so a study can be done in agricultural, urban and a variety of non-traditional environments.

Proturans are a soil micro-arthropods. Studies about soil micro-arthropods can be indicators of the environment health because they are very small creatures in the soil and sensitive to changes in the environment (Barratt *et al.*, 2006; Broza and Izhaki, 1997; Teodorescu and Cogălniceanu, 2005; Convey *et al.*, 2003; Salmon *et al.*, 2006; Jing, 2005; Broza, 1997; Migliorinia, 2004; Paoletti, 1991; Strojan, 1978). In conclusion, there remains much to be discovered.



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