Sedimentary characteristics of sand dune from Bang Berd, Chumphon Province, Southern Thailand

Nattawut Prachantasen[1], Montri Choowong[2*], Santi Pailoplee[2] and Sumet Phantuwongraj[2]

[1] *International Logging Overseas Ltd., Bangkok, Thailand*
[2] *Department of Geology, Faculty of Science, Chulalongkorn University, Bangkok 10330, Thailand*
** Corresponding author: monkeng@hotmail.com*

Abstract

The stratigraphy and sedimentary structures within Bang Berd dune field suggest a geological history that includes paleo-storm deposits. The goal of this project is to characterize the sand dunes in terms of their sedimentological features, including grain size distribution, internal sedimentary structures, wind direction indicators and documenting the evidence for paleo-storm deposits in this area. On aerial photographs, the dunes are aligned in N-W and S-E wind directions. Sand dunes here can be divided, on the basis of their geographic position and their morphological features into 3 units, outer dunes, middle dunes and inner dunes. Interestingly, sedimentary structures within the sand dune are very rare; only well developed inclined lamination can distinguish washover deposits from dune deposits. Both wind-blown and washover sands are very fine-grained, well to very well sorted and subrounded to rounded. The deposition of washover deposits that cover the outer dunes that is aligned in an almost east-west direction may indicate unusual paleo-storm pathways strike into the areas based on alternated washover deposits and dune sequence during 93±18 and 126±14 years ago.

***Key words**: sand dune, washover, OSL, Bang Berd*

1. INTRODUCTION

Sand dunes occur in many environments, including along sea coasts, lake shores and desert. The direction and velocity of wind, in addition to the local supply of sand, result in a variety of dune shapes and sizes (Fritz and Moore., 1987). The individual sand grains were moved by wind along the inclined windward surface. Once they reach the crest and then cascade down the steep reverse side or slip face, piling up at the base and slowly encroaching on new territory (Lindsay et al., 1976).

In the Bang Berd dune field in the northern part of Chumphon Province, Thailand, the preservation of the sand dune makes the area an attractive site for recreation and education. Sand dunes here reach maximum heights of about 20 m above sea level. No detail studies of these dunes, has yet been done. A few previous workers have suggested that the Bang Berd dune field was probably caused by strong winds during past storm seasons (e.g. Choowong and Daorerk. 2004; Choowong and Charusiri. 2005). This project is the first research aimed at understanding the geologic history of this dune field.

2. THE STUDY AREA

The study area is located at Baan Bang Berd, Pathiu District, Chumphon Province, in the western coast of the Gulf of Thailand (Fig. 1). Ban Bang Berd is about 430 km. south of Bangkok at the border between the provinces of Prachuap Khiri Khan and Chumphon, and covers about 25 km^2. The climate of Chumphon province is classified as a tropical monsoon type and a year can generally be sub-divided into 2 main seasons. The first is the wet season which starts from May and lasts in January. This season is influenced by a southwest monsoon between May and September and northeast monsoon between October and January, and is characterized by heavy rainfall. The dry season occurs between February and April. This period is under the influence of the humid and hot southeast monsoon. Since the past 4 decades, this area is no longer affected by typhoons. However, the record of dune stratigraphy may indicate the frequency of the past unusual storms.

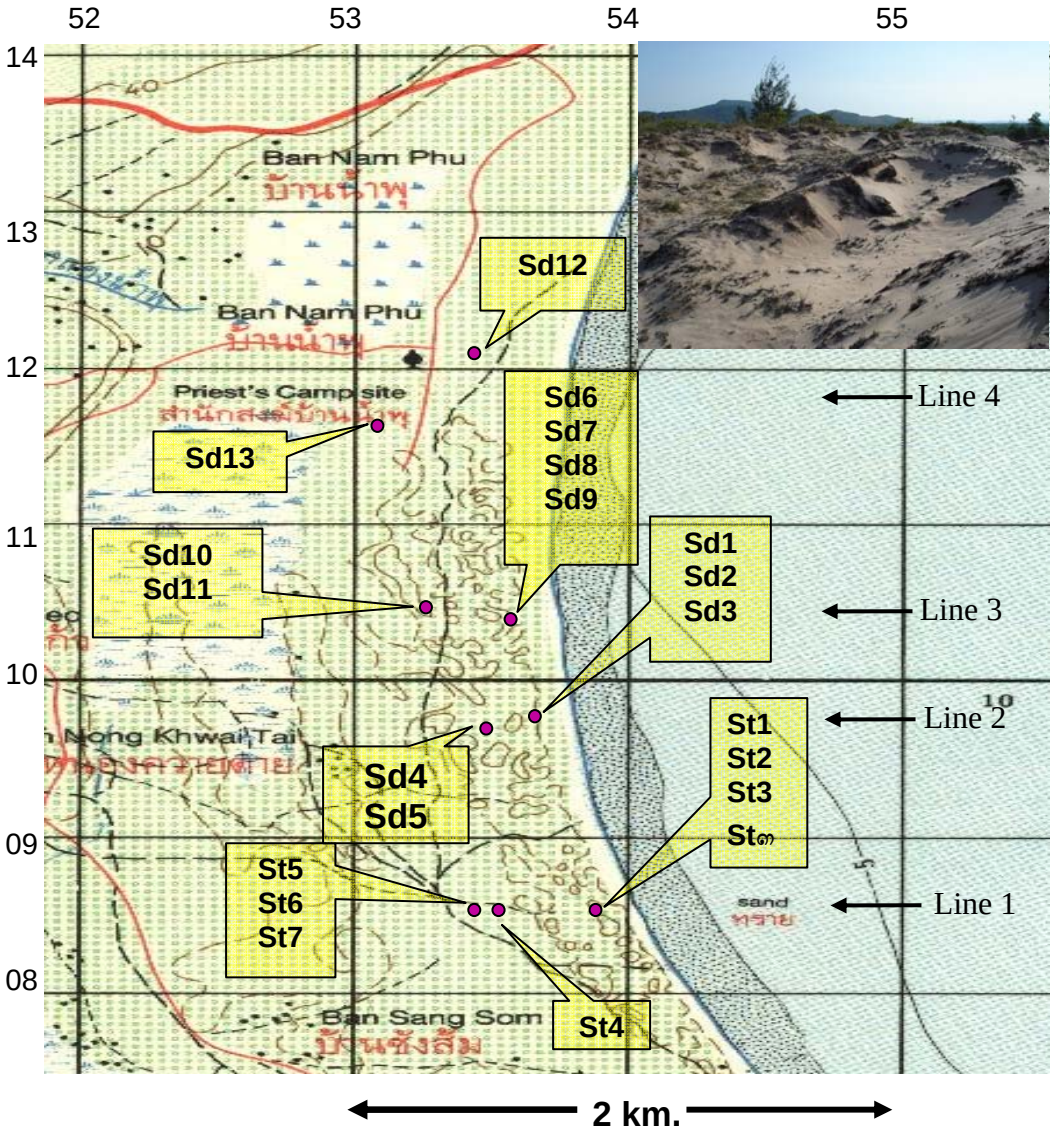
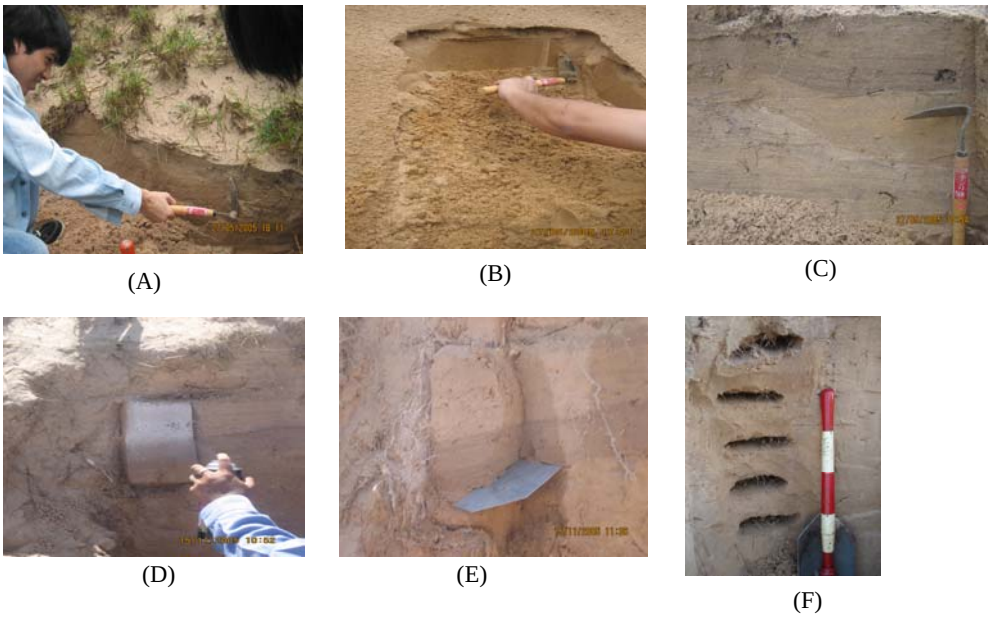


Fig.1. Topographic map showing the study area with locations of test pits and surveyed transects. The inset photo shows typical dunes in the study area.

3. METHODOLOGY

Aerial photographs were used to identify the morphology and distribution of the dunes. Field work was, then, designed to characterize Pits were dug to allow sedimentary structures within the dunes to be described, and topographical profiles were surveyed across the dune field (Fig. 1). Structures were systematically described in a total of 20 pits and 9 natural outcrops. Grain size was analyzed on 68 sand samples. Peels were taken from pit walls to preserve sedimentary structures for later description. Statistical parameters of grain size, including standard deviation, kurtosis and skewness were calculated and plotted in terms of in order to help characterize dune sediments. Careful samplings for Optical Stimulated Luminescence (OSL) dating were also carried out (Fig. 2).



(A) (B) (C)

(D) (E) (F)

Fig. 2. Photographs show methodology in collecting sediment samples in the field; A and B) making 3 dimension excavated pit, C) describe detail sedimentary structures and stratigraphy from excavated pit, D) peel technique to preserve sedimentary profile, E) measure dipping of sedimentary structure and F) collecting samples for OSL dating.

4. RESULTS

4.1 Stratigraphy and internal structures

Stratigraphy and internal structures of sand dune were identified as stratigraphic columns. Each column is made from data gathered from several pits along surveyed topographic transect. Therefore, the composite column exhibited in this paper represents only the topmost part of dune deposits. Fig. 3 represents stratigraphic columns of inner, middle and outer dunes. Washover deposits were alternated with wind-blown dune sediments in each column.

4. 1.1 Inner dune

Stratigraphy and internal sedimentary structures of inner dune include one layer of washover deposit. Washover sediments were identified based on grain compositions which contain heavy mineral patches slightly inclined landward. Total thickness of inner dune from stratigraphic column is about 5.63 m. Some parts of inner dunes were disturbed by land agriculture leading to the combination of human soil within dune deposit.

4.1.2 Middle dune

Washover deposits were separated from wind-blown dune based on their sedimentological features, i.e., landward inclined laminations recognized from heavy mineral patches. Wind-blown dune here shows some wavy structures in multi-directions; on the other hand, washover deposits exhibit only inland deposition. The total thickness of middle dune in composite stratigraphic column is about 8.9 m that indicates top half of dune profile. The stratigraphy shows 5 layers of washover deposits alternated with aeolian dune deposit.

4.1.3 Outer dune

Outer dune field is the closest set of dune morphology to present shoreline but some morphologies of dune were eroded by present shore process, i.e. wave and tidal effects. The outer dune stratigraphic column is about 6.24 meter in thickness that represents about half of the entire dune thickness. However, dune sediment was bioturbated, but some wavy structures of dune deposit were still observed at the bottom of section.

4.2 Topographic relationship of dune field

Elevations within the dune fields in this area vary from 20.5 m to 3 m above the present high tide. We suggest that series of inner wind-blown dunes were made by wind blowing from the NW direction and then the series of middle dunes formed. Topographic lineations of middle dunes indicate deposition in a SE

wind direction. The direction of the wind changed and this change probably reworked the inner dune sediments and redeposited them repeatedly in the middle dune field. The occurrence of washover deposits in the topmost of middle dune stratigraphy indicates that unusual storms hit this area at least 5 times identified from differences in depositional characteristics. Fig. 4 shows present topographic cross sections of dune fields.

4.3. Optical Stimulated Luminescence (OSL) dating

Samples for OSL dating were taken from the topmost layer of dune profile. Sample number BB01-1 and BB01-3 were collected from 2 layers of washover deposit at depths of 10 cm and 20 cm, whereas the other samples were collected from dune deposit at depths ranging from 30 cm to 80 cm below the washover sediment. Result of OSL dating of sand grains indicates the age of washover deposit at 93±18 yrs and 126±14 yrs. Dune sediments beneath washover deposits were dated using OSL technique. Result of OSL reveals the gap between the formations of dune sediment underneath washover deposits. The age of dune sediment shows that the formation of topmost windblown dune occurred between 1,286±247 to 3,258±250 years ago (Table 1). Results of dating dune sediment also suggest that dune sediments might have been re-deposited due to normal wind process.

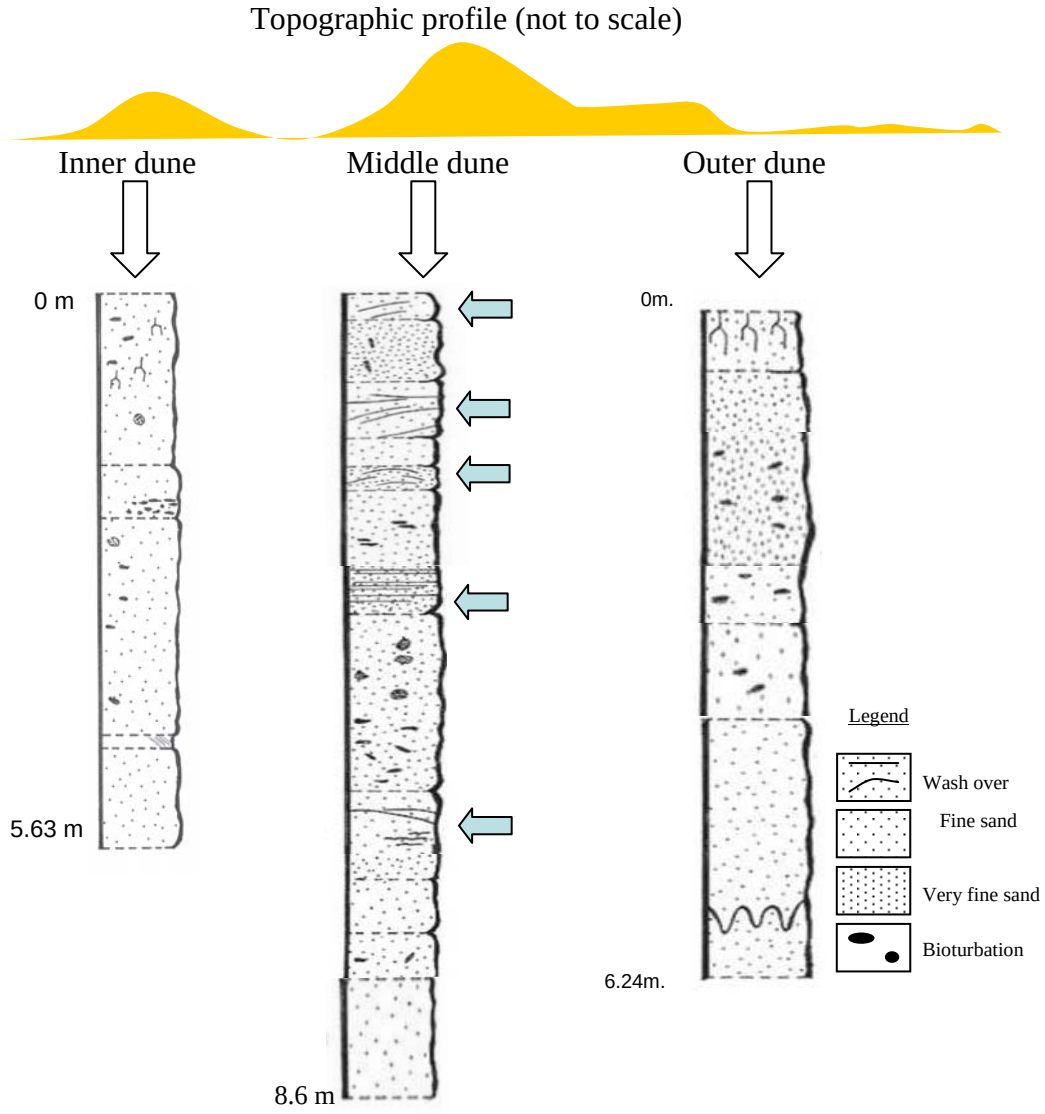
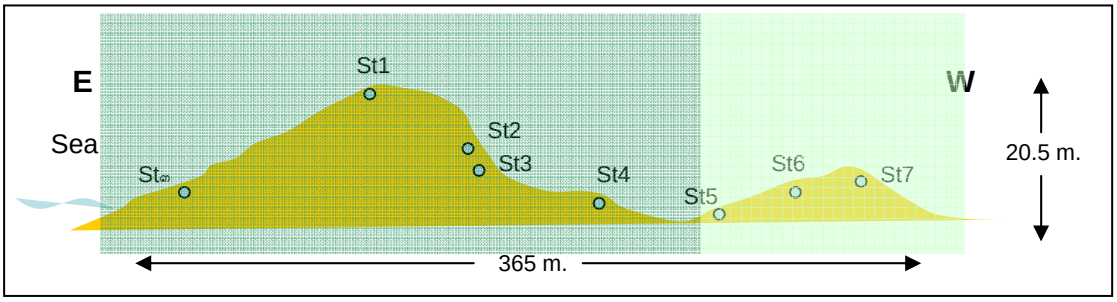
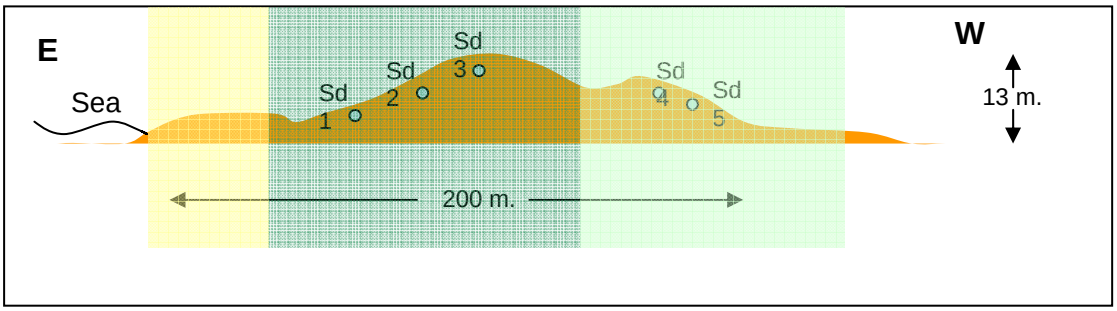


Fig. 3. Stratigraphic sections of inner, middle and outer dunes in this area showing general stratigraphy of dune alternated with washover deposits (indicated by arrows).

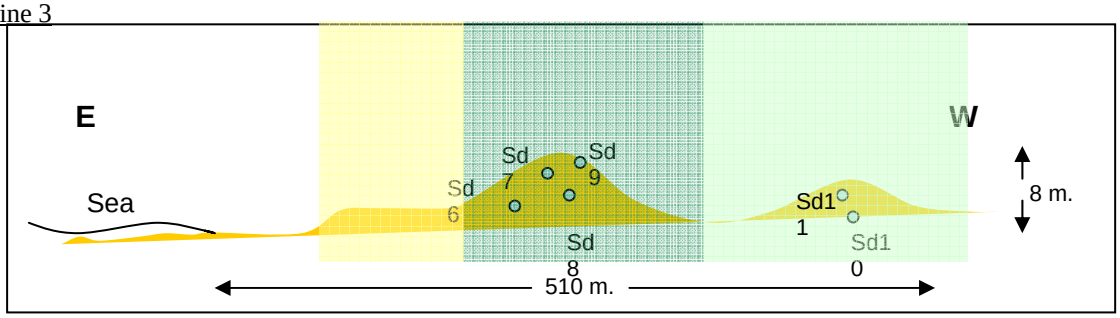
Line 1



Line 2



Line 3



Line 4

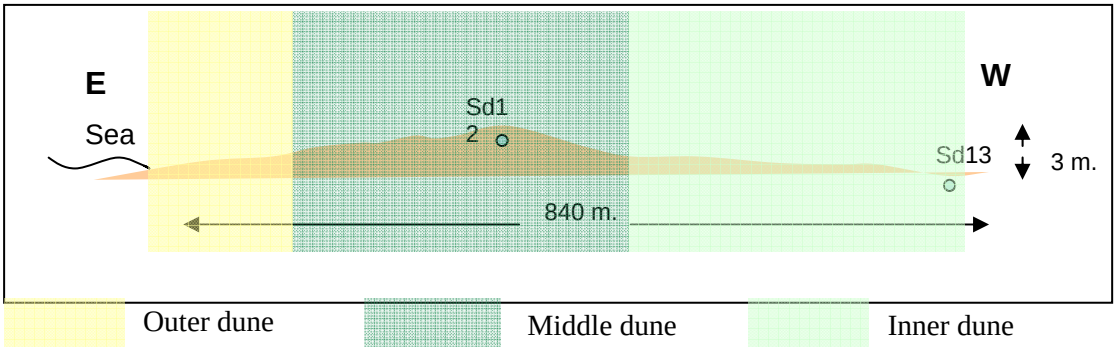


Fig. 4. Topographic relationship of dune field, Line 1 locates in the southernmost part and later lines locate to the north, respectively.

Tab. 1. Results of OSL dating washover and sand dune sediments.

Sample name	U (ppm)	Th (ppm)	K (%)	WC (%)	Annual dose (Gy)	Equivalent dose (Gy)	OSL age (Year)	Error (%)	Final OSL age (Year)
BB01-1	5.51	26.76	0.16	2.89	3.55	0.33	93	0.19147	93±18
BB01-2	3.92	29.17	0.16	3.55	3.33	7.30	2194	0.17672	2,194±388
BB01-3	1.11	4.59	0.13	3.73	0.87	0.11	126	0.11401	126±14
BB01-4	0.67	3.54	0.18	4.32	0.74	2.40	3258	0.07666	3,258±250
BB01-5	1.90	10.77	0.15	3.00	1.53	2.40	1568	0.09402	1,568±147
BB01-6	1.76	8.53	0.18	3.12	1.36	2.98	2190	0.15322	2,190±336
BB01-7	3.89	19.96	0.16	3.10	2.67	3.43	1286	0.19208	1,286±247

Remark: Sample BB01-1 and BB01-3 were taken from similar layer of washover deposit; BB01-2, BB01-4, BB01-5, BB01-6 and BB01-7 were collected from dune deposit from the depth 30 cm, 40 cm, 50 cm, 70 cm, 80 cm below washover deposit, respectively. Artificial irradiation by C^{60} source and Radionuclie (U, Th, K) concentration by NAA were done at Office of Atomic Energy for Peace (OAEP) of Thailand.

5. CONCLUSION

Our goal was to answer the question: what are sedimentary characteristics of this dune field and what do these characteristics tell us about the geological history of the area.

- Interpretation of aerial-photograph briefly indicates the direction of wind-blown sand dune lying in N-W and S-E directions.
- Sand dune can be divided into 3 units based only on geographic position and morphology; outer dune, middle dune and inner dune. The elevation of middle dune is highest and the deposition is thickest comparing to inner and outer dunes.
- Grain size diameter of sand deposit confirms eolian depositional environment. Both wind-blown and washover sands show fine to very fine-grained size, good to very good sorting and is subrounded to rounded.
- Sedimentary structures of dune are very rare, whereas, washover deposits exhibit landward incline lamination recognized from heavy mineral patches. Washover deposits are among good indicator of storm deposits, thus, base on depositional sequences of dune and washover sand deposits (about half thickness of deposition); the study area has been hit by storms at least 5 times.
- OSL dating results show washover sediments were deposited by unusual storm at the age between 93$\pm$18 yrs and 126$\pm$14 yrs. The result of OSL dating reveals that this area was hit by storm and has been storm pathway since several hundreds years ago. However, washover deposits were recognized at the elevation more than 15 m above the present high tide, thus, this is still a challenge to understand coastal and storm processes. Though, the OSL dating method for young sediment is still equivocal, but the result in this research, at least, suggests us to keep doing more research in this dune field.

ACKNOWLEDGEMENTS

This research is partly sponsored by TRF (MRG4680091) and Ratchadapisek Somphot Foundation. Thanks are to EATGRU and NWHEM for providing the opportunity to run OSL dating. Office of Atomic Energy for Peace (OAEP) of Thailand is also thanked for C^{60} artificial irradiation source laboratory. The author would also like to thank Prof. Dr Brady Rhodes and Dr Kruawun Jankaew for reviewing the manuscript. Dr Naomi Murakoshi, Dr Titima Charoentitirat, Miss Rattana Tulthaveewat, Miss Ann Dusitarom are also thanked for wonderful comment during fieldwork.

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