CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

In accordance with the objectives of this research in Chapter 1, the results of this study can be concluded as follows:

1). Fossil algae, pollen, and spores were recovered from Tertiary sediments in northern Thailand. They are described, identified, and illustrated in the chapter on descriptive palynology. The algae include four genera with at least eight species that are freshwater forms such as *Actinastrum* spp., *Botryococcus, Closterium* spp., and *Pediastrum* spp. A fungal form recovered was identifiable at a family level, Microthyriaceae. There are six genera of fern spores with at least nine species including *Crassoretitriletes vanraadshoovenii, Foveotriletes, Laevigatosporites haardtii, Polypodiaceoisporites retirugatus, Polypodiisporites* spp., and *Striatriletes susannae*. There are two groups of pollen, gymnospermic pollen and angiospermic pollen. Gymnospermic pollen includes five genera such as *Inaperturopollenites dubius, Piceaepollenites, Pinuspollenites, Podocarpidites*, and *Tsugaepollenites igniculus*. Angiospermic pollen includes 27 genera such as *Abelmoschus, Alangiopollis, Alnipollenites verus, Calophyllum, Caryapollenites simplex, Combretum, Faguspollenites, Florschuetzia, Homonoia, Hopea, Ilexpollenites, Juglanspollenites verus, Lagerstroemia, Liquidambarpollenites stigmosus, Momipites coryloides, Perfotricolpites digitatus, Pterocaryapollenites stellatus, Quercoidites, Retitrecolpites, Rhoipites, Salixipollenites, Scyphiphora, Spondias, Sporotrapoidites, Striatricolpites*

catatumbus, *Trivestibulopollenites betuloides*, and *Ulmipollenites*. Seventy-five forms of indeterminant sporomorph are described and illustrated in the Appendix.

2). Two categories of fossil sporomorph are classified. They are attributable to recent warm temperate and tropical taxa when their botanical affinities are considered. This classification depends upon a close relationship in morphologies between fossil forms and recent forms and inferring that the similarity in morphology should also implies a similarity in ecology.

3). The recognition of the warm temperate and tropical pollen assemblages plays a significant part in the reconstruction of a Tertiary stratigraphic framework of northern Thailand. There are two palynostratigraphic zones including Oligocene to early Early Miocene warm temperate zone and late Early Miocene to Middle Miocene tropical zone. The boundary between the two zones is gradational and is estimated to be around middle Early Miocene. Because of the stratigraphic position of the boundary zone is not recognized, the precise position of the boundary is still unconstrained. However, the oldest tropical zone is from Na Sai (MN3) containing abundant vertebrate remains and a real tropical pollen assemblage.

4). The warm temperate zone includes Na Hong, Ban Pa Kha, and Mae Lamao localities and the tropical zone includes Na Sai, Mae Long, and Chiang Muan. Mae Moh contains both zones. The warm temperate zone is in the lower part including the lowermost part of the Na Khaem Formation and probably also included the underlying Huai King Formation. The tropical zone includes the rest of the Na Khaem Formation and probably also Huai Luang Formation.

5). Na Hong and lower and upper coal zones of Ban Pa Kha coalfields are equivalent in age. They were developed during the Late Oligocene. The overburden unit of Ban Pa Kha, lower part Na Khaem Formation (Mae Moh), and Mae Lamao are equivalent in age i.e. about early Early Miocene. Na Sai and Mae Long are late Early Miocene. The upper part of Na Khaem Formation (Mae Moh) and Chiang Muan are Middle Miocene.

6). In general, the basins in the west are older and younger towards the east. Na Hong is considered to be the oldest basin in this study which was developed during the Late Oligocene. The younger basins are in the central areas like the Li and Mae Moh basins. Chiang Muan, in the eastern area, is the youngest basin.

7). The occurrences of warm temperate and tropical pollen suggest that there was a change in vegetational pattern from a warm temperate forest to a tropical forest in the northern part of Thailand. This was a result of a climatic change from warm temperate to tropical climate conditions during Oligocene to Miocene time.

8). The climate change was interpreted to be caused by a global temperature change from the Oligocene cooling period to the Miocene climatic optimum. The mechanism of extrusion tectonics of the Southeast Asian landmass during the same period might also enhance such a climate change.

9). Abundant occurrences of freshwater algae and spores and pollen of some aquatic plants from the both zones, indicate that sedimentation of the basins mainly occurred in a fluvio-lacustrine environment. The freshwater palynofloras were found from every basin with abundant occurrence in some horizons. Eventhough there are no forms indicating marginal marine floras from this study but marine incursion events during Middle

Miocene climatic optimum were reported by many workers. The evidence came from palynological and sulfur isotope studies. Marine environment may somehow invaded northern Thailand but detailed mechanism of the marine incursion needs more research.

10). Palynology alone cannot fulfill the Tertiary stratigraphic work of northern Thailand as pollen, spores, and algae do not provide adequate evidence for age determination. Palynology is good for climatic reconstruction especially for tracing major climatic change history. Detailed Tertiary geology of northern Thailand needs more work including multidisciplinary research. Various fields of investigation are recommended such as palynology and paleobotany, vertebrate paleontology, other branches of paleontology, geochemistry, isotope geology, paleomagnetism, sedimentology, and so forth.

11). There is a very high plant biodiversity in tropical rainforests including those in Thailand. A pollen bank of tropical plants is needed to establish standard references of modern palynology for fossil sporomorph comparison. Accurate identification of plant species is needed for the work and careful description of pollen morphology under international standard is required.