Chapter 3

Materials and Methods

3.1 Materials

3.1.1 Materials used for recording geographical data, taking photographs, and interviewing:

1) GPS (Garmin-etrex 10)
2) Camera
3) Questionnaires
4) Measuring tape
5) Recording materials: note book, pencils, permanent markers, and sound recorder

3.1.2 Materials used for specimen collecting:

1) Plastic bags
2) Cutting tools: pruning shears, tree pruners
3) Tags

3.1.3 Materials for pressing and drying, and chemicals for spirit collection:

1) Two pieces of wooden frame
2) Newspapers
3) Corrugated cardboards
4) Sponge sheets (optional)
5) 70% ethyl alcohol and bottles

3.1.1.4 Materials for plant identification

1) Stereo microscope
2) Petri dish, needle, and razor

3.2 Study site selection

To fulfill the objectives of the study, the studied villages were chosen according to the following criteria

1) Villages of the same ethnicity should be located as far as possible from each other. This criterion was proposed to avoid the effect of plant material and knowledge transmission between villages with the same ethnicity. These procedures were followed

    a) Using Muang Chiang Mai district as reference point, Chiang Mai province was divided into two parts, northern and southern, including districts in the north and south of Muang Chiang Mai district respectively.

    b) Choose at least two villages per ethnic group, one from the northern and another from the southern Chiang Mai province.

    c) If the criteria in b) are not satisfied for some ethic groups that live only in one region, two villages, located as far as possible from each other, from that region were selected

2) Other criteria for choosing studied villages included:

    a) The village should not be the location of the urban center of the district or located near that village

    b) Most inhabitants in the village are farmers

    c) Accessible by vehicle

From these criteria, 15 villages from 7 ethnicities were chosen (Fig. 3.1)

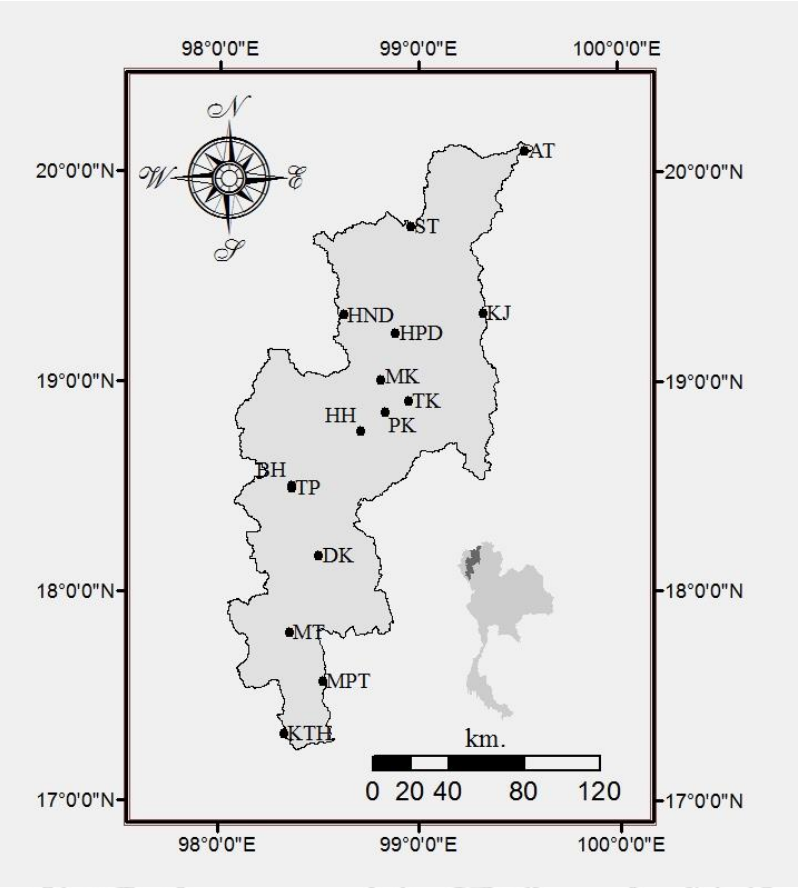

Fig. 3.1 The location of 15 villages in Chiang Mai province in Thailand in which homegardens were studied (Abbrevation (ethnic): AT=Aruno Thai (Yunnan Chinese); BH=Bah Hor (Lawa); DK=Doi Kam (Hmong); HH = Huai Hia (Karen); HND=Huai Nam Dang (Lisu); HPD=Huai Phak Dap (Lahu); KJ=Khun Jae (Lisu); KTH=Khun Tuen Noi (Karen); MK=Meung Ka (Lawa); MPT=Muser Pak Tang (Lahu); MT=Mae Tom (Karen); PK=Pha Nok Kok (Hmong); ST=Suk Rue Thai (Yunnan Chinese); TK=Tha Krai (Thai Yuan); TP=Thong Phai (Thai Yuan))

3.3 Ethnobotanical field survey

Before conducting the survey in each household, the family members were explained the goal of the study, with the help of local guide(s) and their consent for participation was requested. The basic information of the household and homegarden were solicited form all family members at the time of the interview, mainly from household head or housewives. The size of homegarden was informed by the owner(s) then confirmed with the title deed whenever possible. When such information was not available, the size was measured with a measuring tape.

All used species present in each homegarden were recorded for their vernacular name(s), usage(s), origin, the frequency of use and selling, and management. Use information included part of plant used, preparation, and application. Not used species (weeds), according to the informant(s), were excluded. Some species were considered as weeds by the first homegardener but then considered as useful species by other homegardeners. All usages of each species were noted. Use categories followed the *Economic Botany Data Collection Standard* (Cook 1995) with more details available in Appendix II. The used plants were identified, photographed, and samples were collected for preparation of herbarium specimens.

3.4 Plant identification and categorization

All plants found in the homegardens were photographed to aid their identification. Plant vouchers were collected for all plants with the permission from the owners. There were some species for which it was hard to collect the voucher because of they had very large organs. However, these plants were easy to recognize even if to the normal eyes. Examples of these plants included species in Arecaceae like *Cocos nucifera* L. and *Areca catechu* L. The identifications were carried on at the Ethnobotany and Northern Thai Flora Laboratory, Chiang Mai University. All plant names and familes follow the APG system (www.theplantlist.org). Plant specimens were deposited at the Herbarium of Department Biology, Chiang Mai University (CMUB). Each species was assigned to a use category following the *Economic Botany Data Collection Standard* (Cook 1995). Plants were noted as native if they originated in Thailand but exotic if they did not. The origin of the species followed *Tem Smitinand's Thai Plant Names* (Pooma and Suddee 2014).

3.5 Data analysis

3.5.1 *Diversity measurement*

The diversity indices were calculated for the tree species. To evaluate the diversity in homegardens, these indices were calculated for each homegarden:

1) Species richness (S): the total number of species found at the studied site.

2) Shannon index (H): commonly used to define species diversity in a community. The index takes both richness and relative abundances of different species into account, which could be calculated via this formula (Jost 2006):

$$H = \sum_{i=1}^{n} p_i \ln p_i$$

where p_i is the proportion of species i^{th} individuals to total number of individuals in the community.

3) Evenness (E): This index measured the equality of the number of individuals of each species. Eveness assumes a value between 0 and 1 with 1 being complete evenness or every species has the same number of individual. The evenness could be calculated via this formula (Jost 2006):

$$E = H/\ln S$$

where S is the species richness in the community.

3.5.2 Complexity reduction and correlation between diversity indices and household data

Complexity reduction of household data

This method was used in Chapter 6 to reduce the number of factors from household data. Nonlinear principal component analysis (NLPCA) was chosen because these variables included both numerical and non-numerical information in many dimensions. The purpose of NLPCA is, in the same way as that of standard principal components analysis (PCA), to reduce the complexity of the data sets. Unlike standard PCA, NLPCA was used for analyzing variables with different measurement levels including nominal, ordinal, or numeric (Linting and van der KooiJ 2012). The program CATPCA (SPSS statistics ver. 17) was used to compute the NLPCA. The Passive Treatment was used for missing data. Scree plots were also conducted to select number of components and after iterant computations three components were selected for this analysis. The NLPCA scores were used for computing the correlation with diversity indices.

Correlation between diversity indices and household data

To evaluate the effects of household characteristics on plant diversity in homegardens, the correlation between NLPCA scores and diversity indices were calculated. Spearman's rank correlation coefficient was chosen because diversity and evenness index were ordinal scales. For species richness and abundance was log transformed.

3.5.3 *Homegarden similarity measurement*

Hierarchical cluster analysis was used to examine the floristic similarity between homegardens using PAST ver. 3.13. Jaccard similarity index was calculated from presence/ absence data of species in the homegardens. The homegardens were grouped together by Paired group (UPGMA) algorithm. Some homegardens with too low or too high number of species were removed from this analysis.

3.5.4 *Mantel test*

The Mantel test was used to examine the correlation between two distances or similarity matrix (Mantel 1967, Mantel & Valand 1970). The test was carried out by PAST ver. 3.13

3.6 *Zonation*

Each homegarden was divided in up to five zones including (1) FP — fenced plot, (2) FPM — fenced plot margin, (3) Y — yard, (4) HB — homegarden boundary, and (5) P — pot (Cruz-García and Struik 2015). Fenced plots are within the homegardens while fenced plot margins include a 0.5 m wide border surrounding the fenced plots. Yards are the wide space around the house, excluding FP, FPM, HB, and P. Boundaries consist of fences, hedgerows, or other parts that enclose the homegarden. Pots include containers, and old tires. All homegardens did not necessarily possess all zones.