CONTENTS

LIST OF TABLES ................................................................. xii
LIST OF FIGURES ................................................................. xiii
LIST OF APPENDIX ................................................................. xv

GENERAL INTRODUCTION ......................................................... 1
  Background ............................................................. 1
  Objectives ............................................................. 3

MORPHOLOGICAL STUDY ON THE GENUS FREYCINETIA FROM
UMATRA ................................................................. 4
  Introduction ............................................................ 4
  Materials and Methods ............................................. 5
  Results and Discussion ............................................ 6

OLIAR ANATOMICAL STUDY OF FREYCINETIA FROM
UMATRA ................................................................. 17
  Introduction ............................................................ 18
  Materials and Methods ............................................. 18
    Data Analysis ..................................................... 19
  Results and Discussion ............................................ 19
    Epidermis ........................................................ 19
    Stomata .......................................................... 20
    Stomatal size, frequency and index ...................... 26
    Sclerenchym ..................................................... 26
    Hypodermis ....................................................... 26
    Mesophyll ....................................................... 27

TAXONOMIC TREATMENT ...................................................... 34
  Key to Species of Freycinetia in Sumatra .................... 35
  Species Description of Sumatran Freycinetia ............. 37

ECOLOGY OF THE SUMATRAN SPECIES OF FREYCINETIA
HABITAT STUDY AND SPATIAL MODELING ................................ 59
  Introduction ........................................................ 59
    Sumatra .......................................................... 59
    Freycinetia in Sumatra ........................................ 59
  Threads for the existence of the Sumatra species of
    Freycinetia ..................................................... 60
  Materials and Methods ............................................ 61
    Data input and preparation .................................. 61
    Data processing and analysis ................................ 62
    Data output .................................................... 63
LIST OF TABLES

Stomatal Features of Sumatran Freycinetia. All data are counted from abaxial surfaces. Measurements are based on the mean of 10 readings for each species. Detailed data of parameters are listed on Appendix 1, 2, and 3 .................................................. 25

Morphological and anatomical characters selected for phenetic analysis of Sumatran Freycinetia................................................................. 31

Parameters setting for predictive current habitat of the Sumatran species of Freycinetia modelling. Variable of importance rank 1 is most important, on the contrary 6 is least important. Scores in habitat suitability number 3 indicates most suitable, while 1 shows least suitable.......................................................... 65

Distributional and ecological aspects of Sumatran species of Freycinetia. 1A= Aceh; B= Bengkulu; BB= Bangka Belitung; J= Jambi; L= Lampung; R= Riau; NS= North Sumatra; SS= South Sumatra; WS= West Sumatra. 2B= Bushes; LA= Littoral Area; PF= Primary Forest; PSF= Peat Swamp Forest; S= Swamp; SF= Secondary Forest; SwF= Swamp Forest.................................................................. 67

Species of Freycinetia in Sumatra recognised in this study in relation with the annual rainfall in Sumatra. Data without rainfall is marked by stars, * = One location for F. rigidifolia (Natuna Island), ** = two locations for F. imbricata (Iboih Sabang Ecotourism Park), and *** = one location for F. sumatrana (Iboih Sabang Ecotourism Park)............. 71

Species of Freycinetia in Sumatra recognised in this study in relation with the soil units in Sumatra that they inhabit..................................... 73

Predictive Modelling of the habitat of Sumatran species of Freycinetia.......................................................................................... 74
### LIST OF FIGURE

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Scrambling-shrubby habit of <em>F. dewildeorum</em> (A), <em>F. sumatrana</em> climbing on the culms of <em>Gigantochloa alter</em> (B).</td>
<td>7</td>
</tr>
<tr>
<td>2.2</td>
<td>The habit of <em>Frey cinsetia sumatrana</em> at Harau Protected Forest, West Sumatra.</td>
<td>8</td>
</tr>
<tr>
<td>3.3</td>
<td>Unique auricles in three species of Sumatran <em>Frey cinsetia</em>. Horizontally fragmented in <em>F. dewildeorum</em> (A), transparent in <em>F. imbricata</em> (B), and with obviously fimbriated margins in <em>F. rigidifolia</em> (C).</td>
<td>10</td>
</tr>
<tr>
<td>4.4</td>
<td>Shape and colour variations in <em>Frey cinsetia sumatrana</em>, free apices auricles different in colour (A &amp; B); adnate brown auricles and nearly inconspicuous (C).</td>
<td>11</td>
</tr>
<tr>
<td>5.5</td>
<td>Variation in the shapes and colors of bracts, (A) Pistillate inflorescences of <em>F. angustifolia</em>, (B) Single staminate inflorescence of <em>F. imbricata</em>, (C) Pistillate inflorescences of <em>F. javanica</em> (D) Pistillate inflorescences of <em>F. winkleriana</em>.</td>
<td>12</td>
</tr>
<tr>
<td>6.6</td>
<td>Variation of bract colours in <em>F. javanica</em>, bright yellow bracts in Daleng Lancuk (A), pale salmon bracts in Bukit Kaba Ecotourism Park (B), orange bracts in Rimbo Panti (C).</td>
<td>13</td>
</tr>
<tr>
<td>2.7</td>
<td>The inflorescence arrangements in Sumatran species of <em>Frey cinsetia</em>. The arrangement can be racemose as in <em>F. angustifolia</em> (A), solitary as in <em>F. berbakensis</em> (B), pseudo-umbellate as in <em>F. dewildeorum</em> (C), umbellate as in <em>F. imbricata</em>, <em>F. javanica</em>, and <em>F. scabrosa</em> (D-F), the variation in the shape and colour of cephalia in <em>F. sumatrana</em> (G &amp; H), the slightly falcate cephalia of <em>F. winkleriana</em> (I).</td>
<td>14</td>
</tr>
<tr>
<td>2.8</td>
<td>Apical parts of berries showing the stigmatic remains of <em>F. dewildeorum</em> (A), <em>F. distigmata</em> (B), <em>F. javanica</em> (C), <em>F. kamiana</em> (D), <em>F. leuserensis</em> (E), and <em>F. rigidifolia</em> (F).</td>
<td>16</td>
</tr>
<tr>
<td>1.1</td>
<td>Transverse section of leaf; Cu, cuticle; H, hypodermis; Ph, phloem strands; Xy, xylem; E, epidermis; P, palisade; Sc, sclerenchyma; S, sponge.</td>
<td>20</td>
</tr>
<tr>
<td>2.1</td>
<td>Stomatal type of <em>Frey cinsetia</em> (tetracytic type), stomata in abaxial surface (A), and adaxial surface (B).</td>
<td>21</td>
</tr>
<tr>
<td>3.3</td>
<td>Stomata position on epidermal cells, A. Stomata are even to epidermal cell B. Stomata are sunken to epidermal cell or below the leaf surfaces.</td>
<td>21</td>
</tr>
</tbody>
</table>
3.4 Typical stomata within the cell of epidermis, (A) Stomata of *F. angustifolia* with granulated epidermis; (B) Stomata of *F. javanica* randomly scattered; (C) Stomata of *F. imbricata* arranged in rows with distinct costal and intercostals zones and lacking of calcium oxalate crystals; (D) Stomata of *F. sumatrana* in rows with distinct costal and intercostals zones and the presence of the calcium oxalate crystals.

5 Typical stomata of four new taxa, (A) Stomata of *F. berbakensis* with papilose epidermis; (B) Stomata of *F. dewildeorum* in row without distinct differences between costal and intercostals zones; (C) Stomata of *F. leuserensis* with the presence of the calcium oxalate crystals in between the cell of epidermis; (D) Stomata of *F. scabrosa* with the presence of unique calcium oxalate crystals.

6 SEM of two closely similar taxa, (A) Papillose stoma of *F. berbakensis*; (B) Non-papillose stoma of *F. confusa*; (C) Cuboid calcium oxalate crystals on *F. leuserensis*; (D) Unspecialized shapes of calcium oxalate crystals *F. scabrosa*.


8 Dendrogram of Sumatran species of *Freycinetia* based on morphological and anatomical characters.

4.1 Flow diagram showing the process of parameters model setting for predictive current habitat for the Sumatran species of *Freycinetia*.

4.2 Flow diagram showing the parameters model setting of predictive future habitat for the Sumatran species of *Freycinetia*.

4.3 Map of the relation between elevation and the distribution of *Freycinetia* species.

4.4 Map of the relation between rainfall and the distribution of *Freycinetia* species.

4.5 Map of the relation between soil units and the distribution of *Freycinetia* species.

4.6 Map of predictive current habitat for Sumatran *Freycinetia* in Sumatra Island.

4.7 Map of predictive future habitat for Sumatran *Freycinetia* in Sumatra.
# LIST OF APPENDIX

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Stomatal size of the Sumatran species of <em>Freylinetia</em></td>
<td>91</td>
</tr>
<tr>
<td>2</td>
<td>Stomatal frequency of the Sumatran species of <em>Freylinetia</em></td>
<td>93</td>
</tr>
<tr>
<td>3</td>
<td>Stomatal index of the Sumatran species of <em>Freylinetia</em></td>
<td>95</td>
</tr>
<tr>
<td>4</td>
<td>Data matrix of morphological characters for phenetic analysis</td>
<td>97</td>
</tr>
<tr>
<td>5</td>
<td><strong>Plate 1</strong> <em>Freylinetia berbakensis</em> Widjaja, Pasaribu &amp; Hidayat (A. Habit &amp; Leaf, B. Auricle of leaf sheath, C. Stigma, D. Pistillate inflorescence). Drawn from the holotype (Widjaja 7629) by Anne Kusumawaty.</td>
<td>99</td>
</tr>
<tr>
<td>6</td>
<td><strong>Plate 2</strong> <em>Freylinetia dewildeorum</em> Pasaribu (A. Habit, B. Leaf, C. Staminate inflorescence, D. Anther, E. Stigma, F. Berry, G. Pistillate inflorescence with one syncarp in longisection). Drawn from the holotype (Pasaribu 203) by Sobari.</td>
<td>100</td>
</tr>
<tr>
<td>7</td>
<td><strong>Plate 3</strong> <em>Freylinetia leuserensis</em> Pasaribu (A. Habit, B. Leaf, C. Anther, D. Staminate inflorescence, E. Stigma, F. Berry, G. Pistillate inflorescence with one syncarp in longisection). Drawn from the holotype (De Wilde &amp; De Wilde-Duyfjes 20157) by Sobari.</td>
<td>101</td>
</tr>
<tr>
<td>8</td>
<td><strong>Plate 4</strong> <em>Freylinetia scabrosa</em> Pasaribu &amp; Widjaja (A. Habit &amp; Leaf, B. Auricle of leaf sheath, C. Stigma, D. Pistillate inflorescence). Drawn from the holotype (Pasaribu 286) by Anne Kusumawaty.</td>
<td>102</td>
</tr>
<tr>
<td>9</td>
<td>Published Papers</td>
<td>102</td>
</tr>
</tbody>
</table>