

Species Diversity and Habitat Suitability Assessment for Genus *Ficus* in Mae Klong Watershed Research Station, Amphoe Thong Pha Phum, Changwat Kanchanaburi

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ABSTRACT : This study was carried out at Mae Klong Watershed Research Station, Amphoe Thong Pha Phum, Changwat Kanchanaburi, during October 2005 to September 2006, which aimed to assess on figs diversity and applied the geographic information system (GIS) to search for the figs suitable habitats. Five road lines were set up for data collecting with the total distance about 25 kilometers. Those lines were designed to cover all the main habitat types including Mixed Deciduous Forest (MDF), Dry Evergreen Forest (DEF), Deciduous Dipterocarp Forest (DDF), and old Shifting farm land. All figs which located along the line, 10 meter in width, were identified and the recorded location by GPS. Diversity analyzed by Shanon and Weiner Index. Finally, GIS application by overlay technique was used to detect the suitable site of figs. The results showed that 22 *Ficus* species were accumulated. GIS result indicated that the fig suitable habitats depended on moisture factor and those species could be classified into two groups, 1) moisture-specific group, such as *Ficus ischnopoda* Miq., *F. squamosa* Roxb., *F. auriculata* Lour., *F. montana* Burm.f., *F. callosa* Willd., *F. fistulosa* Reinw. ex Blume and *F. racemosa* L. and 2) non moisture-specific group, such as *Ficus annulata* Blume, *F. callophylla* Blume, *F. drupacea* Thunb., *F. geniculata* Kurz, *F. globosa* Blume, *F. hederacea* Roxb., *F. hispida* L.f., *F. microcarpa* L.f., *F. rumphii* Blume, *F. semicordata* Buch. Ham. ex Sm., *F. sundaica* Blume, *F. variegata* Blume and *F. virens* Aiton. The latter group had developed the stomata to protect against water loss.

KEY WORDS : Species diversity, Habitat suitability, Assessment, Genus *Ficus*, Mae Klong Watershed Research Station, Thailand.

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INTRODUCTION

The Genus of *Ficus* is a member of the Family Moraceae. It distributes over the tropical and subtropical of Asia, Australia, Africa, America (and Europe). The dominant characteristic is tree, shrub or climber, often with adventitious root (aerial in hemi-epiphytes and root-climbers), monoecious or (gyno)dioecious (functionally male and female). with milky and white, sometimes coloured or watery, latex. waxy glandular spots (usually) present on leaves (at the base of the midrib or in the axils of the basal or other lateral veins or in main furcations of the venation beneath) or at the nodes of leafy twigs. Leaves spirally arranged, distichous, (sub)opposite or sometimes subverticillate; stipules fully amplexicaul to lateral, mostly free. Inflorescences with an urceolate receptacle (syconium or fig) with a narrow circular or slit-shaped orifice(ostiole), bracts on the peduncle (peduncular bracts), subtending the receptacle (basal bracts, mostly 2 or 3); on the outer surface of the receptacle(lateral bract), in the orifice of the receptacle(ostiole bracts), among the flowers(interfloral bracts) and/or subtending (staminate) flower (bracteoles). Figs bisexual (with staminate flowers and pistillate flowers with styles of different lengths) or (functionally) unisexual either with staminate flowers and (non-seed-producing) pistillate flowers with short styles or with long-styled pistillate flowers(and neuter flowers), pronouncedly protogynous; staminate flowers sessile or pedicellate, with 2 - 5 (or more) free to almost fully connate tepals, stamens 1-5, pistillode absent or present; pistillate flowers sessile or pedicellate, with 3-5 (or more) free to fully connate tepals, ovary free, styles different in length, stigmas 2 and filiform to subulate or 1 and filiform to subulate or clavate to infundibuliform, cohering or free. Fruit a drupelet or achene, small. Seed with endosperm, embryo (almost) straight with flat and equal cotyledons or \pm curved with conduplicate cotyledons. (Berg

and Corner ,2005. Condit, 1947. Corner,1960. King,1969. Ridley,1924.)

The stomata of leaf are limited to the lower side. In subg. *Urostigma*, the stomata are sunken in connection with the development of the lower hypodermis, and an annular ridge of cuticle often forms an outer chamber. In other subgenera the sinking of the stomata is caused by elongation of epidermal cells without hypodermis, so that the stomata lies at the bottom of a cylindrical pit. The same occurs in a few hemi-epiphytic species with sunken stomata. (Berg and Corner, 2005)

Berg and Corner (2005) reported that figs were classified into 6 subgenera, 1) subg. *Ficus* : Shrubs, small to medium-sized(or tall) trees, with white milky sap, (gyno)dioecious. 2) subg. *Pharmacosycea* (Miq.) Miq.: Tree (or shrub), terrestrial, monoecious, Leaves spirally arranged or (sub)distichous; 3) subg. *Sycidium* (Miq.) Mildbr. & Burret, : Trees, tall to small, shrubs, or climbers (or creepers), terrestrial or (hemi-) epiphytic; with intermitten or continuous growth; milky sap mostly white. 4) subg. *Synoecia* (Miq.) Miq.: Root-climber, with climbing stems and branches, with short roots on the nodes and internodes, and often non-rooting branches, bearing the figs. Leaves on rooting branches (bathyphylls) in size, shape and texture mostly different from those on non-rooting (and fertile) branches (acrophylls), 5) subg. *Sycomorus* (Gasp.) Miq. : Trees or shrubs, with white or yellowish latex, monoecious or (gyno)dioecious. Leafy twigs with the internodes often hollow or, if solid, then often with copious pith and 6) subg. *Urostigma* (Gasp.) Miq. : Monoecious tree, with aerial adventitious roots, mostly hemi-epiphytic and the secondary system of aerial roots anastomosing and forming root-baskets (around trunks of host-trees), secondarily terrestrial (or primarily so) and then often forming pillar roots, sometime hemi-epilithic, or rarely climber.

The species of *Ficus* are mainly tropical. Comparatively few are subtropical and subtropical. The genus is also reflected in its altitudinal distribution. Most of the tropical species occur in lowland and submontane zones below 1500 m. a small number occur in the montane zone between 1500 and 2400 m, most species belong to vegetation subject to an ever-wet climate, but there are several which seem to be indifferent to the distribution of rainfall and can extend into the typical monsoon climate. The genus is absent in mangroves, but some species, as *Ficus microcarpa*, can often be found in brackish swamp. Many species occur in fresh water swamps. Hemi-epiphytic species often invade villages, orchards, and town-gardens, establishing themselves on trees and walls. They can also often be found on limestone hills, rocky cliffs, and rocky headlands by the sea. Several species are rheophytic and can thus be found in and along swift rocky streams. (Berg and Corner, 2005)

In the nature, plant can grow prosperously in suitable environment due to their ecological niche. Kutintara (1998) reported that the environmental factors can be divided into two groups. The first groups are abiotic factors such as energy source, climatic factors, edaphic factors, topographic factors and forest fire. The later group biotic factors such as plants, animal, micro-organism, fungi and human. Those factors may play the important role on plant distribution, however, it depended on plant species with differences in ecological niche.

The Geographic information system (GIS) is a powerful set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes (Burrough and McDonnell, 1998). Thus, GIS can be applied for analyzed the environment factors which is the limiting factor for species distribution by overlay technique and others to know the suitable site of that species.

The diversity of figs and an habitat suitability were carried from Mae Klong Watershed Research Station, Amphoe Thong Pha Phum, Changwat Kanchanaburi, western part of Thailand. The watershed area covered about 109 square kilometers and the elevation ranged from 80- 950 m above mean sea level. The average annual rain fall is about 1,538 mm. and the average monthly temperature is about 27 °C. The vegetation types were divided into four types such as 1) Mixed deciduous forest (MDF), with bamboos, 2) Deciduous dipterocarp forest (DDF), 3) Dry evergreen forest (DEF) and 4) Disturbed area which were divided into two types as Agricultural area and old shifting farm land.(Suksawang, 1993)

METHOD

The methods can be divided into two processes; species diversity and GIS process.

The species diversity process was done by road side count technique. Five road lines were set up to record the species and location of the figs in the field, with the total distance of 25 kilometer. Those lines were 10 meter wide and designed to cover all the main habitat types, MDF, DEF, DDF and disturbed areas. The species identification was followed the monumental works of Berg (2003a, 2003b, 2003c, 2003d, 2004), Berg and Corner (2005), Corner (1960, 1961), King (1969) and Ridley (1924).

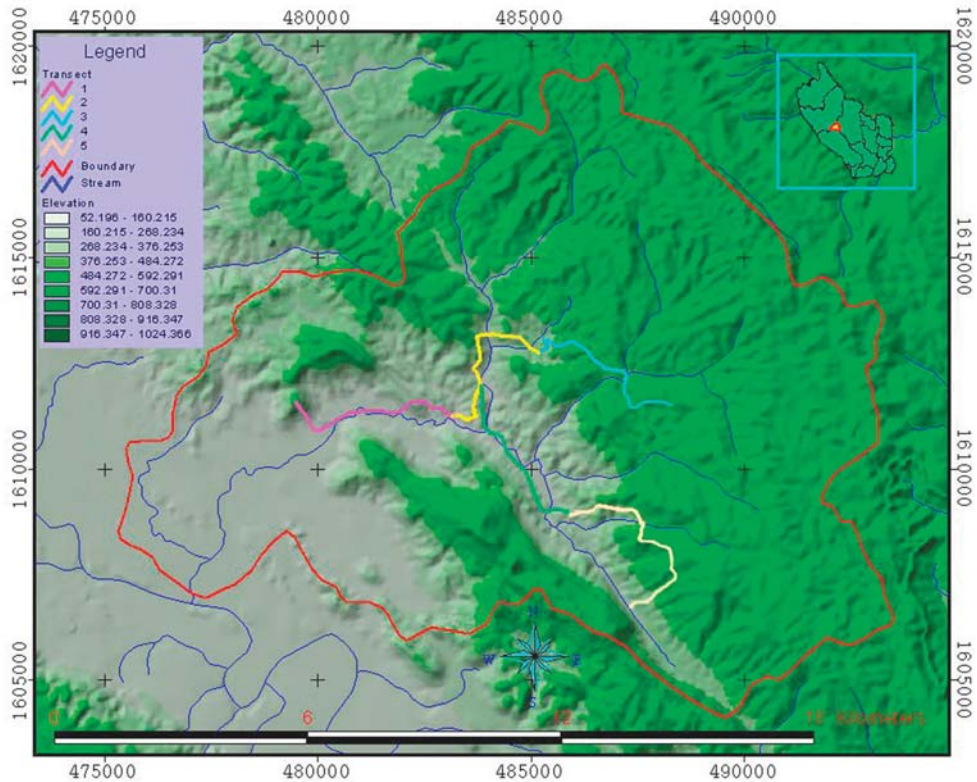


Figure 1: Five road line 1) pink line with cover on disturbed area, 2) yellow line with cover on MDF, 3) green line cover on MDF, 4) orange line cover on MDF and DEF, 5) pale blue line cover on MDF and DEF.

The analysis of diversity index was calculated by Shanon and Weiner index.

$$H' = \sum_{i=1}^s Pi \ln Pi$$

- H' = Shanon and Weiner index
- S = Number of species in the area
- Pi = () ; i = 1,2,3.....,s
- ln = Natural log (e = 2.718)
- n = Number of stem in each species
- N = Total of all stems of species

The GIS Process was used by the potential surface analysis. Five main factors were analyzed such as 1) distance from the main stream, 2) elevation, 3) aspect, 4) slope and 5) forest type. The environmental data was transformed into digital data and analyzed by the overlay technique (Pattanakiat, 2003)

- S = $W_1R_1 + W_2R_2 + \dots + W_nR_n$
- S = suitable habitat
- W1...n = weighting factor 1 to n
- R1...n = rating factor 1 to n

RESULT

The species diversity

The result showed that 22 species of *Ficus* were found in the area under investigation, and can be divided into 6 subgenera; [only one species in three subg., *Ficus ischnopoda* Miq. in subg. *Ficus*, *F. callosa* Willd. in subg. *Pharmacosycea* and *F. montana* Burm.f. in subg.

Sycidium, two species in subg. *Synoecia*, seven species in subg. *Sycomorus* and ten species in subg. *Urostigma*. (Table 1)]

The Shannon and Weiner diversity index value of *Ficus* at Mae Klong Watershed Research Station was 2.43. Its quite low diversity about 23 % of *Ficus* species of Thailand.

Table 1. List of Fig species in Mae Klong Watershed Research Station

Subgenus	Species	Dominant characters
<i>Ficus</i>	เดื่อน้ำ <i>Ficus ischnopoda</i> Miq.	Rheophytic shrub, up to 3 - 5 m, dioecious. Figs pedunculate, 1.5 - 2 cm, receptacle ellipsoid, 1 - 1.5 cm in diam. when fresh, glabrous, dark red to brown at maturity.
<i>Pharmacosycea</i>	เดือกวาง <i>Ficus callosa</i> Willd.	Deciduous tree, up to 30 m, monoecious. Figs pedunculate, 1 ñ 2.5 cm, receptacle globose, 2 - 3 cm in diam. when fresh, glabrous, pale green at maturity.
<i>Sycidium</i>	<i>Ficus montana</i> Burm.f.	Creeping shrubs, up to 2 m tall, dioecious. Figs pedunculate, 0.2 - 0.5 cm, receptacle depress-globose, 0.7 - 1.2 cm in diam. when fresh, orange to dark-red at maturity.
<i>Synoecia</i>	เดื่อเถาใบหอก <i>Ficus sagittata</i> J. König ex Vahl	Root-climber, dioecious, lamina sagittate when young, elliptic to oblong on fig-bearing branches. Figs pedunculate, 0.5 - 1 cm, receptacle depressed-globose, 1.3 - 1.5 cm in diam. when fresh, orange at maturity.
	<i>Ficus hederacea</i> Roxb.	Root-climber, dioecious, lamina ovate. Figs pedunculate, 0.5 - 1 cm, receptacle depressed-globose, 0.8 ñ 1.3 cm in diam. when fresh, yellow to orange at maturity.
<i>Sycomorus</i>	เดื่อผา <i>Ficus squamosa</i> Roxb.	Rheophytic shrub, up to 2 - 3 m tall. Dioecious. Figs pedunculate; receptacle pyriform, 2 ñ 3 cm in diam. when fresh, dark hair, yellow at maturity.
	มะเดื่อปล้อง <i>Ficus hispida</i> L.f.	Tree up to 10 m tall, dioecious, Figs born on main branches or stem or axillary or on stolon, pedunculate; receptacle globose to pear-shaped, 2 ñ 4 cm in diam. when fresh, yellow at maturity.

Table 1. Continued.

Subgenus	Species	Dominant characters
<i>Sycomorus</i>	ผูก <i>Ficus variegata</i> Blume	Tree up to 25 m tall, dioecious, Figs born on main branches or stem, pedunculate; receptacle sub-globose, 2 ñ 3 cm in diam. when fresh, orange to red at maturity.
	เดื่อหว่า <i>Ficus auriculata</i> Lour.	Tree up to 15 m tall, dioecious, Figs born on main branches or stem, pedunculate; receptacle subpyriform, 3.5 - 4.5 cm in diam. when fresh, orange to red at maturity.
	ชิง <i>Ficus fistulosa</i> Reinw. ex Blume	Tree up to 7 m tall, dioecious; Figs born on main branches or stem or axillary, pedunculate; receptacle subpyriform or subglobose, 1.1 - 1.9 cm in diam. when fresh, yellow at maturity.
	เดื่อสาย <i>Ficus semicordata</i> Buch. ñHam. ex Sm.	Tree up to 10 m tall, dioecious, Figs flegelliflorous, pedunculate; receptacle subglobose, 1.8 ñ 2.3 cm in diam. when fresh, orange to red-brown at maturity.
	มะเดื่ออุทุมพร <i>Ficus racemosa</i> L.	Tree up to 20 m tall, monoecious, Figs born on main branches or stem, pedunculate; receptacle subglobose, 2.2 - 3 cm in diam. when fresh, orange to red at maturity.
<i>Urostigma</i>	ไทร <i>Ficus annulata</i> Blume	Hemi-epiphytic, evergreen, tree up to 30 m, monoecious, fig pedunculate, 0.5 - 1 cm long; receptacle ovate, 2.5 - 3 cm in in diam. when fresh, glabrous, pale green to pale yellow when ripe.

Table 1. Continued.

Subgenus	Species	Dominant characters
<i>Urostigma</i>	ไทรย้อยใบแหลม <i>Ficus benjamina</i> L.	Hemi-epiphytic, evergreen, tree up to 25m, monoecious, fig sessile; receptacle globose to obovate, 0.8 - 1 cm in diam. when fresh, glabrous, yellow to orange to black when fully ripe.
	ไทรใบสารภี <i>Ficus callophylla</i> Blume	Hemi-epiphytic, evergreen, tree up to 30 m tall, monoecious, Figs sessile; receptacle ovate to globose, 1 ñ 1.2 cm in diam. when fresh, glabrous, orange to red or to dark brown (sometime pink) at maturity.
	ลุงขน <i>Ficus drupacea</i> Thunb.	Hemi-epiphytic, deciduous, tree up to 30 m tall, monoecious, young branches tomentose. Figs sessile; receptacle oblong, 1.3 - 1.6 cm in diam. when fresh, tomentose (when fresh), glabrous (when older), yellow to orange-red at maturity.
	ยางอินเดีย <i>Ficus elastica</i> Roxb.	Hemi-epiphytic, deciduous, tree up to 30 m tall, young branch glabrous. Figs sessile; receptacle oblong, 0.7 -1.2 cm in diam. when fresh, glabrous, pale yellow at maturity. Basal bract forming in cup shape
	ไทรลูกกลม <i>Ficus globosa</i> Blume	Woody climber; evergreen, monoecious, lamina elliptic to ovate. Figs pedunculate 0.4 - 0.6 cm long; receptacle globose, 1.5 - 2.1 cm in diam. when fresh, glabrous, pale green to pink at maturity.
	โพชั่นก <i>Ficus rumphii</i> Blume	Hemi-epiphytic, deciduous, tree up to 25 m tall, monoecious, lamina heart-shaped. Figs sessile; receptacle obovate to globose, glabrous, 1.2 ñ 1.6 cm in diam. when fresh, black at maturity.

Table 1. Continued.

Subgenus	Species	Dominant characters
<i>Urostigma</i>	ฝักเลียด <i>Ficus virens</i> Aiton	Hemi-epiphytic, deciduous, tree up to 25 m tall, monoecious, Figs sub-sessile receptacle ovate or globose, glabrous, 0.8 - 1 cm in diam. when fresh, at first white and black at maturity.
	โพรชัยใบหูก <i>Ficus microcarpa</i> L.f.	Hemi-epiphytic, evergreen, tree up to 25 m tall, monoecious, Figs sessile; receptacle globose, 0.8 ñ 1 cm in diam. when fresh, glabrous, black at maturity.
	<i>Ficus sundaica</i> Blume	Hemi-epiphytic, evergreen, tree up to 25 m tall, monoecious, Figs sessile; receptacle globose, 0.8 - 1 cm in diam. when fresh, glabrous, orange to red-brown at maturity.

The Suitable Habitat

The analysis of GIS showed that the suitable habitat of fig species in Mae Klong Watershed Research Station was limited by moisture factors. Figs can be divided into two groups due to their moisture relationship; such as specific-moisture and non-specific moisture group. However, the relationship between each factor can be described below.

Elevation factor: The elevation range from 100 ñ 600 m above mean sea level (asl). In this area, the forest changed from Mixed deciduous forest (100 - 500 m asl) to DEF (above 500 m asl) MDF will lack of water in the dry season MDF faced to severe drought, however dominant species were adapted to drought. The elevation factor slightly showed the impacted on figs distribution, because figs can be distributed all the study areas.

Forest type factor; the main forest type in Mae Klong Watershed Research Station are MDF, DDF and DEF with forest fire and

moisture factors were the main factors to maintain those forest. DEF has higher moisture content than in MDF and DDF very few of forest fire occurred in DEF. *Ficus fistulosa* Reinw. ex Blume, moisture ñspecific species can be found in DEF.

Aspect factor: The aspect usually towards to west and slightly to the south. Thus, the aspect was less impact on figs distribution.

Slope factor: Figs species can grow widely from gentle to upper slope. Thus, this factor may not be the main factor on Figs distribution.

Distance from stream factor: The distance from stream sources created the different moisture condition areas. The results showed that *Ficus squamosa* Roxb. and *Ficus ischnopoda* Miq. were found only closed to the stream areas and those were moisture-specific species. Thus, the distance from stream factor or moisture condition played the important role on figs distribution in this area.

Table 2 Habitat Suitability for Genus *Ficus* in Mae Klong Watershed Research Station

Species	Altitude (m from msl.)	Forest type	Exposure	Slope(%)	Distance from stream (m.)
<i>Ficus annulata</i> Blume	99-53	MDF	N,NE,S,SW,W	11-30	12.17 - 205.35
<i>Ficus auriculata</i> Lour.	92-315	MDF	N,NE,NW,S,SW,SE	2-26	5.17 - 69.12
<i>Ficus callophylla</i> Blume	161-639	MDF	N,NE,S,SW	15-32	140.70 - 278.18
<i>Ficus callosa</i> Willd.	98-272	MDF	N,NW,NE,S,SW,SE	2-13	40.01 - 62.16
<i>Ficus drupacea</i> Thunb.	96-411	MDF	N,NW,S,SW,W	4-27	2.42 - 350.43
<i>Ficus fistulosa</i> Reinw. ex Blume	408-544	DEF, MDF	N,NW,S,SW,W	25-40	235.23 - 271.18
<i>Ficus globosa</i> Blume	521-667	DEF, MDF	N,NE,NW,SW	8-37	2.34 - 362.48
<i>Ficus hederacea</i> Roxb.	383-476	DEF, MDF	N,NE,NW,SW,W	2-30	53.27 - 241.33
<i>Ficus hispida</i> L.f.	89-506	MDF	N,NE,NW,S,SW,SE,W,E	3-34	39.58 - 866.32
<i>Ficus ischnopoda</i> Miq.	105-133	MDF	N,NE,NW,S,SW,W,SE,E	6-13	1.23 - 13.28
<i>Ficus microcarpa</i> L.f.	95-632	DEF, MDF	N,NE,NW,S,SW,W	2-23	10.27 - 248.67
<i>Ficus montana</i> Burm.f.	135-156	MDF	S,SW,W	6-23	5.87 - 43.27
<i>Ficus racemosa</i> L.	88-431	MDF	N,NE,W,NW,S,SW,SE	1-23	3.99 - 53.70
<i>Ficus rumphii</i> Blume	94-322	MDF	N,NW,NE,S,SE,E	11-29	1.77 - 154.23
<i>Ficus sagittata</i> J. Konig ex Vahl	408	MDF	SW	28	256.47
<i>Ficus semicordata</i> Buch. - Ham. ex Sm.	273-426	MDF	N,NE,NW,SW,SE,S,W,E	2-29	23.14 - 457.81
<i>Ficus squamosa</i> Roxb.	132-352	MDF	N,NE, NW,SW,SE,S	2-31	2.15 - 26.62
<i>Ficus sundaica</i> Blume	96-647	MDF	N,NW,W,SW,S	2-35	10.93 - 137.75
<i>Ficus variegata</i> Blume	116-509	MDF	N,NE,NW,W,SW,SE,S	4-25	152.40 - 641.24
<i>Ficus virens</i> Aiton	96-599	MDF	N,NW,W,SW,SE,S	2-33	70.82 - 348.46

Note: DEF : Dry evergreen forest, MDF : Mixed deciduous forest; N = North, E = East, S = South, W = West, NE = Northeast, NW = Northwest, SE = Southeast, SW = Southwest.

CONCLUSION

The diversity of Figs in this area is quite high in which 22 species, were found and can be divided into two group due to their main limiting factor on the distribution as;

1. Moisture-specific group: It usually grows near the stream, less than 20 m from stream, such as *Ficus racemosa* L., *F. auriculata* Lour., *F. squamosa* Roxb. and *F. ischnopoda* Miq.

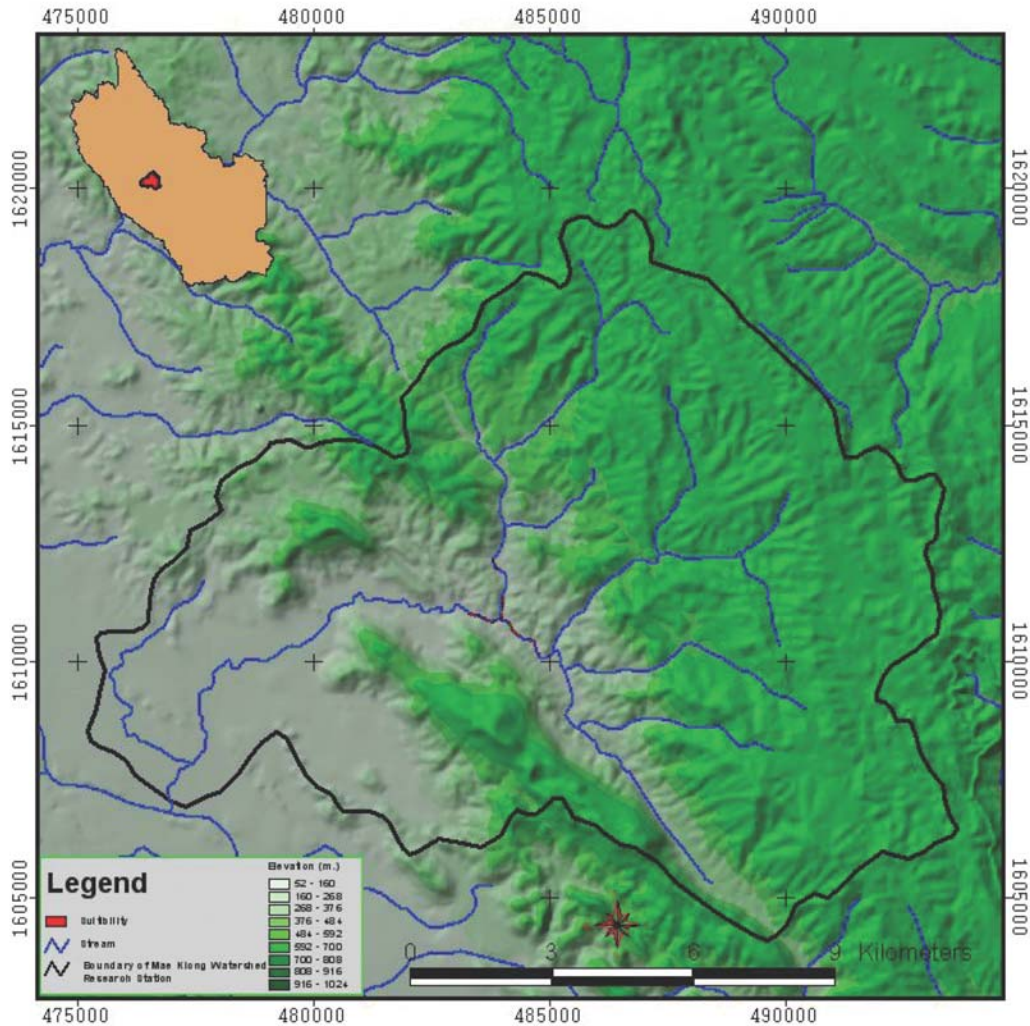


Figure 2 Suitability habitat map of moisture-specific group; *Ficus ischnopoda* Miq.

2. Non moisture-specific group; Its occurrence far from stream, over 20 m distance far from which was drier than the first group. Subg. *Urostigma* mostly found in this group. The habit is hemi-epiphytic with have more durability and match to the structure of stomata.

The stomata of subg. *Urostigma* are mostly sunken in connection with the development of the lower hypodermis, and an annular ridge of cuticle often forms an outer chamber. This character was prevented from losing water.

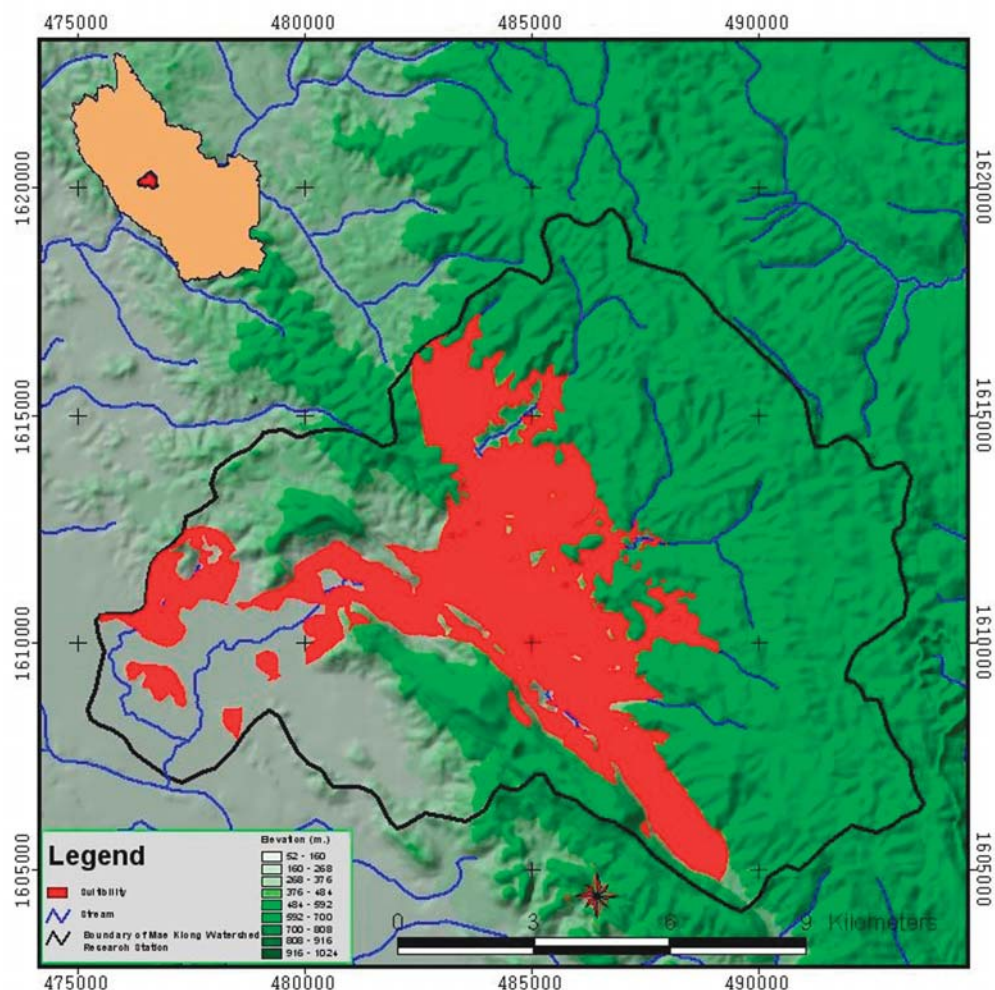


Figure 3 Suitable habitat map of non moisture-specific group; *Ficus hispida* L.f.

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