# THE PECULIAR HABITAT AND PLANT COMMUNITIES OF THE WEN-SHAN FOREST DISTRICT, FORMOSA

by

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## INTRODUCTION

The region of Wen-Shan Forest District lies in the southern part of the Taipeh Political District, between the northern latitude 24°35′ to 25°5′ and eastern longitude 121°23′ to 121°58′ with an area of 329 sq. km. Physiographically speaking it is the northern extension and branch of the central mountain range of the island, with steep slopes and rugged hills, caped with various types of plant communities. The valleys are deeply cut and rivers with very short courses. Climatically speaking this region, in addition to the attacks of regular typhon-storms, is under the influences of the strong N. E. winter monsoon and the prevailing S. W. summer monsoon, which attack the region steadily and respectivelly. Owing to have such a physiographic complex and such a climatic variabilities, the development of vegetation in this region is extremely complicated with each local small areas. This would give more interests to the plant ecologists to study this particular region intensively.

The former botanists have made studies on some areas in the vicinities of this region with a rather different object of views, such as: Mr. T. Suzuki(5), A plant-sociological study on the undergrowth of the *Cryptomeria*-plantation in the Laurisilvae district of North Taiwan, in which he has made quadrat studies on sociological development of the undergrowth of *Cryptomeria*-plantations; Mr. S. Susuki and Mr. H. Shimizu(3), A list of the plants from Wantan along the midstream of the River Tansui, in which they have compiled a list of 550 species of plants found in that small area; Mr. T. Suzuki(4), On the moor and marsh vegetation, in which he has made ecological studies of the plants in the vicinity of Taiwan University; Mr. T. Suzuki(6), A preliminary report on the association in the Laurisilvae in Togokei District, north Taiwan, in which he has made studies of 150 quadrats and classified the plant associations from the Laurisilvae in a small area of only 5,100 hectares. He has recognized *Machilus-*, *Shiia-*, and *Symplocos-* three principal associations in that region located about 20 km. south of the Taiwan University. All the above workers have attempted to study the vegetations of this region either floristically, or ecologically, but their works were limited to too small areas and with particular object of views.

The chief object of this study is from an ecological view-point to determine the relationships between this peculiar habitat and the complicated plant communities consquentially resulted, covering a broader area of the whole forest district, and with a hope that this study may serve some guidances to a proper management of this forest district.

## GENERAL FEATURES OF THE ENVIRONMENTAL CONDITIONS

Climatically speaking this region is located just on the border-land of 3 distinct climatic divisions, namely: the north-eastern winter monsoon, the south-western summer monsoon, and the central mountain region. Each of the three has a particular feature of climate. The north-eastern corner of the district prevails with the winter N. E. monsoon wind bringing in more rainfalls, which will not only cause disastrous damages to the land surface by floodings, but also diminish the sun-shine days to the region affecting the growth and development of plants tremendously; the northern side of the district, owing to its northern exposure, has the coolest winter than the others, and the southern side, due to the effect of the S. W. summer monsoon, receives more rainfalls and more damp airs but more strong sun-shines, has more warmer summer than the other sides; while the central mountain range extends its northern branches into this district in various directions. As we know that the altitude increases, the temperature lowers normally with an average rate of being 0.45–0.5 degree C. per 100 meters and the precipitation, the relative humidity, and the day-light duration are reversed but varying in correspondence with the differences in elevations and mountain exposures. This district may be said a transitional zone of the N. E. winter and the S. W. summer monsoon and their correlative effects adding the effect of the central mountain range would cause a great diversity in local climatic conditions, hence a great complexity of plant communities are resulted in this region.

The mean annual temperature of the district is 22°C. and the mean annual precipitation is 2,000 mm. at altitude of 500 m., 3,000 mm. at 1,000 m., and 4,000 mm. at 1,500 m. above. In general the winter season is wet and summer dry. The mean annual evaporation power of the air of the whole district is 1,587 mm.. The average winter relative humidity of the district is 84%.

The growing season of this district is about 300 days of the year. The sun-shine rate is 50–60% at low-level and only 20–30% on high elevations, therefore the sun-shine on high mountains is about 20% in shortage for plant growth.

Soils on higher places of the region, being nonfertile, have been derived from rocks of the upper tertiary red-sand stone and gray schist, of reddish brown and grayish green in color, while those alluvial soils along the river courses, owing to have organic and humus contents, are dark green and more fertile than those on the higher places, however, the alluvial soils are limited to small areas and the majority of the district is of poor reddish and grayish-green sterile soils.

Owing to have such a diversified physiographic and climatic conditions the region has developed a very variable associations of plant community within many small areas. In general, every mountain or hill in the region has two different types of vegetation on its north-eastern and south-western slope at the same altitude. On the former, the site being more moist, the floristic composition is richer in species and made of mainly of hydrophytic evergreen hardwoods and with a mixture of very few deciduous trees, which grow denser and taller and with more epiphytes and rattans on them; and on

the latter, the site being more suny and dry, the floristic composition is more simple in species, more xerophytic and shrubby in nature and with less epiphytes and rattans. That is the reason why this district especially good for tea plantations and particulary good on the south and southwestern slopes of the mountains, as the reddish sandy soils and warm suny dry summer and moderate cool wet winter climate are specially suiting such a more or less xerophytic shrubby type of vegetation. Thus tea, citrus, bamboos, rose-apples, guavas, and a number of Lauro-Fagaceous species are the dominant plants of this region.

## ALTITUDIAL DISTRIBUTION OF PLANT COMMUNITIES

The elevation of this region lays between 50 m.–2,600 m. above the sea level. All the areas below 300 m. have practically been cultivated and the natural vegetation within the cultivated areas destroyed by human beings. Hence this study was made starting from the point of about 300 m. above the sea level along the northern slopes of the mountains upwardly. Within this range of elevation 3 principal forest belts may be generally recognized:

(1) From 300 m. elevation up to 1,000 m. is the warm everygreen broad-leaved forest belt. The floristic composition of this belt is mainly of trees and shrubs belonging to the family Lauraceae and the genera *Machilus*, *Actinodaphne*, and *Cinnamomum* being the principal ones and the family Fagaceae with the genera *Quercus* and *Lithocarpus* being the dominant trees. The "Lauro-Fagaceae" association has generally been called by many ecologists. In addition the following trees are also found in this association as subordinates:

*Schefflera octophylla* Harms.
*Gordonia axillaris* Syzyl.
*Tutcheria shinkoensis* Nakai
*Michelia compressa* Maxim. var. *formosana* Kaneh.
*Ardisia Sieboldii* Miq.
*Sapindus Mukorossi* Gaertn.

It is very interesting to note, however, that within this hardwood assocoation belt there are two conifers, namely (1) *Heyderia formosana* Li (or *Libocedrus formosana* Florin), being limited to the elevation of 300–750 m. in scattered distribution and really in groups and (2) *Keteleeria Davidiana* Beissn. var. *formosana* Hay., being confined to a small stand not from Pin-ling-wei. This is a special feature and worth of note that the genus *Pinus* of 2 or 3 species are usually found at this elevation of the neighboring regions, but very rare in this district. The common shrubs found in this association are:

*Symplocos Konishii* Hemsl.
*Helicia formosana* Hemsl.
*Turpinia tenata* Nakai
*Aralia bippinate* Blanco
*Aralia Decaisneana* Hance

*Broussonetia papyrifera* Vent.
*Ficus Beecheyana* Hook. & Arn.
*Ficus gibbosa* Bl.
*Daphniphyllum Oldhamii* Rosenth.
*Glochidion Forunei* Hance.
*Glochidion lanceolatum* Hay.
*Mallotus japonicus* Muell.-Arg.
*Wendlandia paniculata*, DC.
*Eugenia formosana* Hay.
*Photinia taiwaniana* Hay.
*Pithecolobium lucidum* Benth.
*Engelhartia formosana* Hay.

This broad-leaved association belt may be subdivided into 2 vertical sections, from the elevation 500 m. to 550 m. being taken as a transitional belt. Taking the principal tree species of this Lauro-Fagaceous association into consideration, in Lauraceae, the distribution of the species of the 3 dominant genera, namely, ***Machilus***, ***Actinodaphne***, and ***Cinnamomum***, in the upper section (550 m.–1,000 m.) is as follows:

*Machilus zuihoensis* Hay.
*Actinodaphne nantoensis* Hay.
*Actinodaphne mushanensis* Hay.
*Cinnamomum randaiense* Hay.
*Cinnamomum pseude-laureirii* Hay.

Those that distribute in the lower section (300 m.–500 m.) are as follows:

*Machilus Kusanoi* Hay.
*Machilus Thunbergii* Sieb. & Zucc.
*Actinodaphne pedicellata* Hay.
*Cinnamomum camphora* Nees.
*Cinnamomum micranthum* Hay.

The phenomena of such vicarious distribution in altitude among the genera is also very notorious in Fagaceae. Such as the species of ***Quercus*** and ***Lithocarpus*** of Fagaceae distribute in the upper section as follows:

*Quercus variabilis* Bl.
*Quercus longinux* Hay.
*Lithocarpus Kawakamii* Hay.
*Lithocarpus ternaticupula* Hay.

Those that are found in the lower section are as follows:

*Quercus gilva* Bl.
*Quercus glauca* Thunb.
*Shiia uraiana* Kaneh. (*Limlia uraiana* Masam. et Tomiya.)

Moreover, in the upper section of the warm evergreen broad-leaved belt, the members of the Lauraceae develop more vigorously than those of the Fagaceae.

The common shrubs and small trees found in the lower section of the belt from the elevation of 300–550 m. are as follows:

*Adinandra formosana* Hay.
*Cleyera japonica* Thunb.
*Glycosmis pentaphylla* Corr.
*Melastoma septemnervium* Lour.
*Liquidambar formosana* Hance.
*Sapium discolor* Muell.-Arg.
*Pithecolobium lucidum* Benth.
*Rhus semialata* Maxim.
*Rhus sylvestris* Sieb. & Zucc.
*Boehmeria densiflora* Hook. & Arn.
*Debregeasia edulis* Wedd.
*Pouzolzia elegans* Wedd.
*Aralia bipinata* Blanco.
*Callicarpa formosana* Rolfe.
*Ficus Beechyana* Hook. & Arn.
*Styrax suberifolium* Hook. & Arn.

These shrubs and small trees found in the upper section of the belt, from the elevation of 550–1,000 m. are as follows:

*Tetrapanax papyriferum* K. Koch.
*Deutzia taiwanensis* Schneid.
*Eleocarpus Kobanmochi* Koidz.
*Meliosma rigida* Sieb. & Zucc.
*Neolitsea Konishi* Kaneh. et Sasaki
*Ilex Hanceana* Maxim.
*Litsea cubeba* Pers.
*Litsea Hayatae* Kaneh.
*Rhododendron ellipticum* Maxim.
*Lindera glauca* Bl. var. *Kawakamii* Hay.
*Phoebe formosana* Hay.
*Callicarpa Loureiri* Hook. et Arn.
*Callicarpa pillosissima* Max.
*Illicium arborescens* Hay.

The tree-ferns are thriving in this section very well. The most common species are as follows:

*Alsophila formosana* Bak.
*Alsophila postulosa* H. Chr.
*Cyathaea taiwaniana* Nakai

The common lianes, semi-lianes, and scramblers found in this belt of evergreen broad-leaved association are as follows:

*Uncaria formosana* Hay.
*Echysanthera utilis* Hay. et Kawakami.
*Pueraria Thunbergiana* Benth.
*Hydrangea* spp.
*Ficus vasculosa* wall.
*Embelia penduliramula* Hay.
*Stautonia obovatifoliota* Hay.
*Climatis Gouriana* Roxb.
*Pericampylus glaucus* Merr.
*Stephania japonica* Miers.
*Fissistigma Oldhamii* Merr.
*Rubus spp.*
*Smilax* spp.
*Actinidia formosana* Hay.
*Schefflera arboricola* Hay.
*Epipremnum mirabile* Schott.
*Psychotria serpens* Linn.
*Hoya carnosa* R. Br.
*Marsdenia tinctoria* R. Br.
*Ipomoea indica* Merr.
*Blumea pubigera* Merr.

Although the main composition of plants of this association is made of evergreen broad-leaved trees and shrubs, but there are also deciduous and semi-deciduous trees and shrubs found here and there in the association, however, they are very rare and scattered. Those deciduous and semi-deciduous forms are as follows:

*Liquidambar formosana* Hance.
*Alnus formosana* Makino.
*Trema orientalis* Bl.
*Ficus Wrightiana* Wall.
*Prunus campanulata* Maxim.
*Lagerstroemia subcostata* Koechne.
*Acer Oliverianum* Pax. var. *Nakaharai* Hay.
*Rhus semialata* Mun. var. *Roxburgiana* D. C.
*Rhus succedanea* Linn.
*Ilex asprella* Champ.
*Melia azedarach* Linn.
*Alniphyllum pterospermum*, Mats.
*Litsea cubeba* Pers.
*Fraxinus Griffithii* C. B. Clarke.
*Evodia glauca* Miq.
*Engelhartia formosana* Hay.

*Sapindus Mukorossi* Gaertn.
*Callicarpa spp.*
*Sapium discolor* Muell.-Arg.
*Stereospermum sinicum* Hance.

(2) From 1,000 m. up to 1,600 m. elevation above the sea level is the mixture of temperate coniferous and broad-leaved forest belt. The principal trees of conifer in this belt are:

*Chamaecyparis formosensis* Matsum.
*Chamaecyparis obtusa* Sieb. & Zucc. var. *formosana* Rehd.
*Cunninghamia Konishii* Hay.
*Taxus spciosa* Florin (*Taxus chinensis* Rheder)
*Tsuga chineniss* Pritzel.

It is very interesting to note that *Chamaecyparis formosensis* distributes in this district as the lowest in elevation than in any other regions in Formosa. It starts to appear at the elevation as low as 850 m., though there are not many and it does not develop very well. Up to 1,000 m. and above, *Chamaecyparis formosensis* develops very thriftily and mixes with the evergreen broad-leaved trees, but the former appears to be more superior than the latters. One pronunced indication of changing the vegetation of warm evergreen broad-leaved forest belt to a temperate coniferous and evergreen broad-leaved mixed type is by the disappearance of tree-ferns suddenly and subsituting them with *Fatsia*, a genus of Araliaceae, at the elevation of about 1,000 m. above the sea level.

*Chamaecyparies obtusa* var. *formosana* appears at the elevation of about 1,200 m. and above which it gradually takes the place of *C. formosensis* as dominant tree in the association. *Cunninghamia Konishii* though very rare in this belt, often forms pure stands in small patches. *Taxus chinensis* being found at this elevation only two sapling-specimens, which are the sprouts of the cut-over stumps. *Tsuga chinensis* appears at the elevation of 1,500-1,600 m. sparcely mixed with *Chamaecyparies obtusa* var. *formosana.*

The principal evergreen broad-leaved trees in this belt are generally the same as that of the warm evergreen belt. The most important ones are:

*Actinodaphne nantoensis* Hay.
*Actinodaphne mushanensis* Hay.
*Machilus zuihoensis* Hay.
*Cinnamomum peudo-Laureiri* Hay.
*Trochodendron aralioides* Sieb. et Zucc.
*Illicium arborecens* Hay.
*Tetrapanax papyriferum* K. Koch.
*Michelia compressa* Maxim. var. *formosana* Kaneh.
*Tutcheria shinkoensis* Nakai
*Schefflera octophylla* Harms.

*Daphniphyllum membrenaceum* Hay.

In the mixtures of conifers and hardwood forest belt of the temperate regions of the northern hemisphere the deciduous hardwoods are generally more dominant than the evergreen broad-leaved species, while in that of Formosa, due to its lower latitude, higher temperature, higher percentage of relative humidity, and more precipitation, the case is automatically reversed and the evergreens are more than deciduous ones. The following deciduous trees, though not many, are found in this belt:

*Acer Oliverianum* Pax var. *Nakaharai* Hay.
*Alnus formosana* Makino
*Alniphyllum pterospermum* Matsum.
*Liquidambar formosana* Hance.
*Litsea cubeba* Pers.

(3) Form 1,600 m. above is the cool temperate forest belt. This belt consists of small area of the district. They are only those tops of few higher mountains in this region. The principal trees that form a pure coniferous forest are:

*Tsuga chinensis* Pritzel.
*Chamaecyparies obtusa* Sieb. et Zucc. var. *formosana* Rehd.

*Taxus speciosa* Florin should be found in the association here but somehow it was disappeared and substituted by a kind of small bamboo, *Arundinaria* (*Pleioblastus*) *niitakayamensis* Hayata.

## DISCUSSION

Broadly speaking to take the Island Formosa as a whole, except its southernmost portion, at the elevation between 300–1,000 m. above the sea level the plant association is the Lauro-Fagaceae belt, which is the eastern extension of the laurel belt of the mainland China. The principal plants constituting this association are *Machilus* spp., *Michelia spp.*, *Quercus spp.*, *Castanopsis spp.*, *Lithocarpus spp.*, *Shiia spp.*, *Symplocos spp.*, *Daphniphyllum spp.* etc. They are usually forming groups or consociations in each of their prevailing dominancy to every peculiar habitat condition within the association. The structure of the association is stratified in 4 or 5 stories, that is the dominant, sub-dominant, suppressed, shruby, and herbaceous stories being generally recognized. Any one of the above mentioned principal genera and species may be the dominant member in this locality or habitat and sub-dominant or even suppressed in the other, depending upon each ones optimum environment provided to it by various local habitats. Thus the climatic influences of the oceanic currents, the N. E. and S. W. monsoon winds, and the dissected mountain ranges running in various directions giving numerous narrow steep valleys and various slope-exposures resulting differences in intensity of solar radiation and day-time duration, the percentage of relative humidity, the rate of the evaporation power of the air and others, would vary with every small locality of the district and this would consquently result a very complicated plant communities within this broad type of Lauro-Fagaceae association. In general, the plant

association on the N. E. slopes is consisting mostly of evergreen broad-leaved trees and mixing with less number of deciduous species, while that of the S. W. slopes at the same elevation, due to have longer day-light duration and stronger solar radiation and higher evaporation power of the air, is consisting of less number of evergreens and more deciduous trees and the association shows to be more xerophytic and shrubby in nature. A comparative study of the percentage of the forest-component-classes occupied the association between the N. E. and S. W. slopes at the same elevation of about 750 m. has been made. Two quadrats on each side of 10 sq. meters each have been laid out and the numbers of plants of each class have been counted. The average results in percent are as follows:

The percent of plant-component classes

| On the N. E. slopes | | On the S. W. slopes | |
|---|---|---|---|
| Class | % occupied | Class | % occupied |
| Dominant-trees | 12 | Dominant-trees | 8 |
| Subdominant | 13 | Subdominant | 14 |
| Shrubs | 24 | Shrubs | 30 |
| Herbs | 30 | Herbs | 34 |
| Lianes | 4 | Lianes | 3 |
| Epiphytes | 15 | Epiphytes | 11 |
| Total | 100 | Total | 100 |

The above table given us a decided contrast of the composition of vegetation between the N. E. and S. W. slopes at the same elevation. Quadrats studies made by Messrs. S. Suzuki and H. Shimizu(3) in Wantan along the midstream of the river Tansui, which is not far north of this district, have shown a pretty close nature in composition to this district, although their studies were made in rather lower altitude. Furthermore, *Chamaecyparis formosensis* begins to appear in this district at the elevation of as low as 850 m., while its lowest distributional elevation in Tai-Pin Shan, which is only 20–30 km. south of this region, is 1,200 m. and in all other regions south of Tai-Pin Shan it generally begins to appear at the lowest elevation of 1,500–2,000 m.; and 2,000 in the other regions; the same situation is showed by *Chamaecyparis obtusa* var. *formosana* with its lowest elevation of distribution in this region is 1,200 m., and 2,000 m. in the other regions; *Tsuga chinensis* in 1,600 m. in this region and generally above 2,000 m. in other regions; and *Taxus speciosa* begins to appear at 1,200 m. in here and very rare below 2,000 m. in any other regions. Another very interesting fact may be noted that *Pinus taiwenensis* Hay. and *P. massoniana* Lamb. growing in Tai-Pin Shan and Pa-Sian Shan, which are not more than 80 km. south and south-west of this district, at the elevation of 700-800 m., are supposed to be found in this district at this elevation, but none, exept some artificial plantations; It is also noticeable that the rapid disappearing of the tree ferns—*Cyathaea taiwaniana, Alsophila formosana,* and *Alsophila postulosa* immediately above the elevation of 1,000 m. espe-

cially so on the southern slopes they are substituted by *Fatsia* of the family Araliaceae, which generally grows much higher in elevation in other regions nearby this district. All the above facts indicate that the peculiar climatic and physiographic habitats of this district have brought about such an intricate plant communities within the association and lowered down the elevation of distribution of a certain species to their abnormal limits.

## SUMMARY AND CONCLUSION

1. Phytogeographically speaking this region is an eastern extension of the Laurel belt of the southern part of mainland China.

2. Owing to the influences of the ocenanic currents of the east and west of the island Formosa, the N. E. and S. W. winter and summer monsoon, and rugged physiographic features, the habitat of this district is very complicated.

3. The factor of complexity of this region has developed diversified groups of plant community within the Lauro-Fagaceous association in rather small areas.

4. The particular ecological features of this region bring about much lower distributional limit in elevation of many important species of plants such as, ***Chamecyparis formosensis, Ch. obtusa*** var. ***formosana, Tsuga chinensis, Taxus speciosa,*** which grow much higher in elevation in other regions nearby this district.

5. The forest management plan of this district in reforestation, in conversive cutting of natural forests for replantation, and in selection of cutting methods, should be carefully drawn and not blindly follow the principles of vertical distribution limit of certain species applying to large areas in this district.

6. Especially the practice of tea plantation, which is now carrying on in this district extensively, owing to have variable habitat with each small localities, should not take large tract of land or cover the whole mountain as one unit of cultural treatment, but small areas with intensive studies of their individual environmental conditions be needed and highly recommended.

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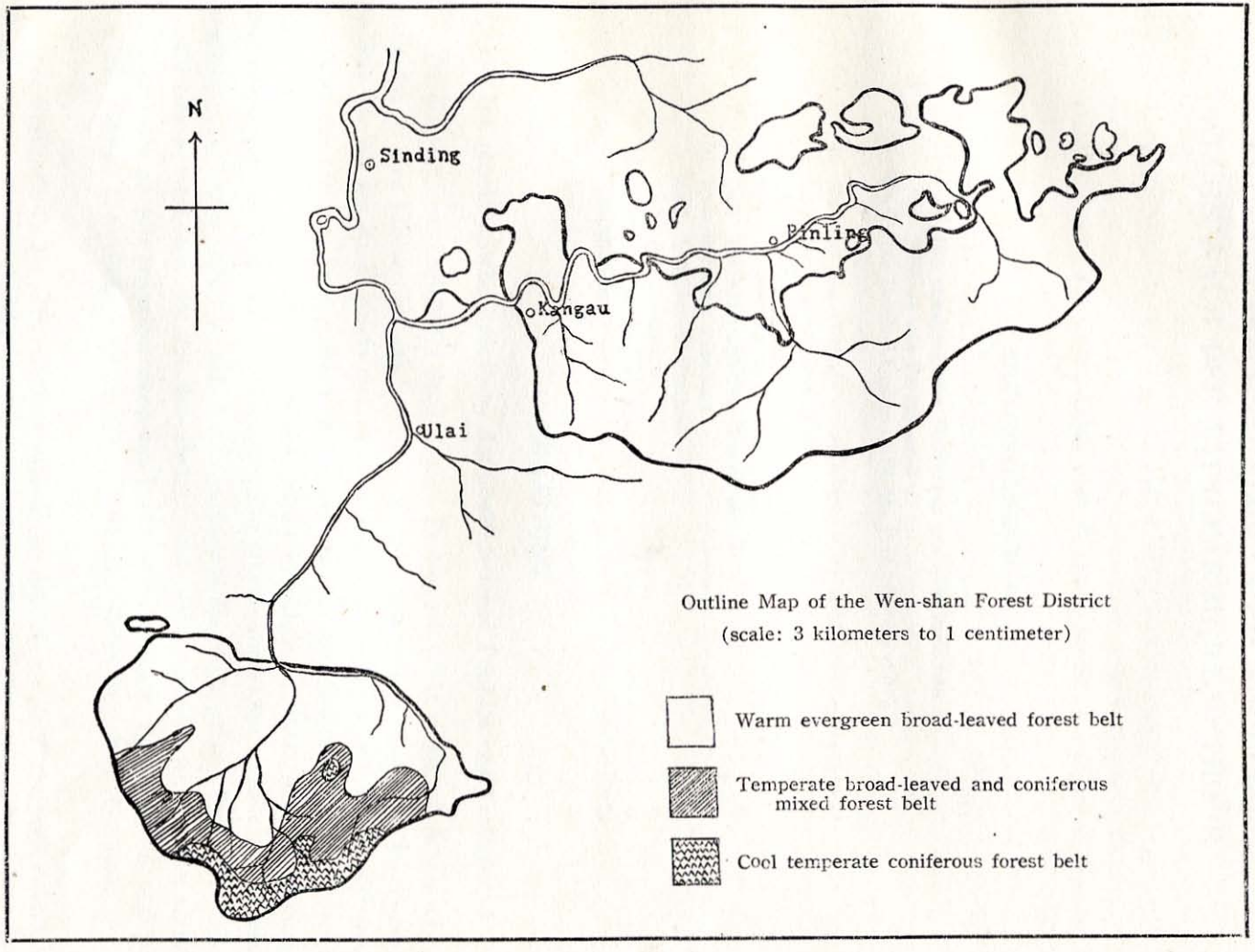
N
Sinding
Pinling
Kangau
Ulai
Outline Map of the Wen-shan Forest District
(scale: 3 kilometers to 1 centimeter)
Warm evergreen broad-leaved forest belt
Temperate broad-leaved and coniferous mixed forest belt
Cool temperate coniferous forest belt