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Studies on the Cenozoic Plants of Hokkaidô and Karahuto

IV. On the Tertiary *Tilia* from Hokkaidô and
Karahuto

By

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With 1 Plate

(Contribution from the Department of Geology and Mineralogy, Faculty of
Science, Hokkaidô Imperial University, Sapporo. No. 311).

The genus *Tilia* is now widely distributed in the temperate regions of northern hemisphere, though the majority are confined in their distribution to the eastern Asiatic regions. In Japan, *Tilia* forms a common element of arborescent trees in the mountain forest belt of Hokkaidô, Honsyû, Sikoku, Kyûsyû, and Tyôsen and it comprises 14 species and 2 varieties,¹⁾ namely;

- T. amurensis* RPRECHT (Jap. Name: Amur-Sinanoki). Distribution: Tyôsen.
- T. amurensis* RPRECHT forma *polyantha* NAKAI (Jap. Name: Hana-Amur-Sinanoki). Distribution: Tyôsen.
- T. amurensis* RPRECHT var. *grosseserrata* NAKAI (Jap. Name: Oni-Amur-Sinanoki). Distribution: Tyôsen.
- T. Franchetiana* SCHNEIDER (Jap. Name: Kobano-Sinanoki). Distribution: Honsyû.

1) After T. MAKINO and K. NEMOTO: Flora of Japan, 1931; K. NEMOTO: Flora of Japan, Supplement, 1936. As to the specific names of modern *Tilia* in Japan, the present writers owe also to Prof. M. TATEWAKI, Faculty of Agriculture, Hokkaidô Imperial University, to whom their cordial thanks are due. Besides the species listed above, MAKINO and NEMOTO, op. cit., enumerate also *T. europaea* L. and *T. Miqueliana* MAXIM., but these are mostly cultivated in Japan and not yet seen in wild condition in this country.

- T. insularis* NAKAI (Jap. Name: Takesima-Sinanoki). Distribution: Uturyô Is.
- T. japonica* SIMK. (Jap. Name: Sinanoki). Distribution: Hokkaidô, Honsyû, Sikoku and Kyûsyû.
- T. japonica* SIMK. var. *leiocarpa* NAKAI (Jap. Name: Kenasi-Sinanoki). Distribution: Sikoku.
- T. kiusiana* MAKINO and SHIRASAWA (Jap. Name: Heranoki). Distribution: Honsyû, Sikoku and Kyûsyû.
- T. koreana* NAKAI (Jap. Name: Tyôsen-Sinanoki). Distribution: Tyôsen.
- T. mandshurica* RUPR. et MAXM. (Jap. Name: Mansyû-Bodaizyu; Oh-Sinanoki). Distribution: Tyôsen.
- T. Maximowicziana* SHIRASAWA (Jap. Name: Ôba-Bodaizyu). Distribution: Hokkaidô, Honsyû.
- T. Maximowicziana* SHIRASAWA var. *yessoana* TATEWAKI (Jap. Name: Moiwa-Bodaizyu). Distribution: Hokkaidô.
- T. megaphylla* NAKAI (Jap. Name: Kara-Bodaizyu). Distribution: Tyôsen.
- T. megaphylla* NAKAI forma *subintegra* NAKAI (Jap. Name: Maruba-Oh-Bodaizyu). Distribution: Tyôsen.
- T. ovalis* NAKAI (Jap. Name: Kôrai-Bodaizyu). Distribution: Tyôsen.
- T. rufa* NAKAI (Jap. Name: Kitune-Sinanoki). Distribution: Tyôsen.
- T. semicostata* NAKAI (Jap. Name: Bodaizyu-Modoki). Distribution: Tyôsen.
- T. Taquetii* SCHNEIDER (Jap. Name: Kuwanoha-Sinanoki). Distribution: Saisyû Is.

The fossil records of the genus is also frequent in the eastern Asiatic region than in any other parts of the world; they are mostly represented by leaf impressions, though occasional discovery of floral bracts proves the former existence of this genus in the eastern parts of the Asiatic continent. Under the generic name *Tilia* the followings are heretofore known to us from Japan and its adjacent lands:

Karahuto (incl. Sachalien) :

- **T. remotiserrata* sp. nov. Nayosi, Nayosi-gun. Kawabataian.
T. sachalinensis HEER.¹⁾ Mgratch, Sachalien. Probably Kawabataian.

Hokkaidô :

- **T. harutoriensis* sp. nov. Harutori coal-mine, Kusiro City. Urahoroian.
 **T.* sp. Abura, Prov. Siribesi. Kawabataian.

Honsyû and Kyûsyû :

- T. distans* NATHORST. Mogi²⁾ and Amakusa³⁾ Nagasaki pref., Neogene; Omi⁴⁾, Nagano pref. Miocene.
T. japonica SIMK. Siobara⁵⁾, Totigi pref. Pleistocene.
T. sp. NATHORST.⁶⁾ Mogi, Nagasaki pref. Neogene.
T. sp. FLORIN.⁷⁾ Amakusa, Nagasaki pref. Neogene.
T. sp. FLORIN.⁸⁾ Simonoseki, Yamaguti pref. Neogene.
T. sp. KON'NO.⁹⁾ Omi, Nagano pref. Miocene.
T. sp. NATHORST.¹⁰⁾ Kannonzaka in Prov. Etigo, Niigata pref. Neogene.
T. sp. SHIKAMA (list only).¹¹⁾ Near Kôbe City, Hyôgo pref. Miocene.

* Species described in the present paper.

- 1) O. HEER: Primitiae Florae Fossilis Sachalinensis. Miocene Flora des Insel Sachalin. Flora Fossilis Arctica, vol. V, Abth. 3, 1878, p. 47, pl. XII, Figs. 6, 7.
- 2) A. G. NATHORST: Zur fossilen Flora Japans. Pal. Abh., Bd. IV, Heft 3, 1888, p. 65, pl. VI, figs. 5-13.
- 3) R. FLORIN: Zur Kenntnis der jungtertiären Pflanzenwelt Japans. Kgl. Svensk. Vet. Akad. Handl., vol. LXI, no. 1, 1920, p. 25, pl. II, fig. 9.
- 4) E. KON'NO: Cenozoic Flora of Central Sinano (Japanese), in HOMMA: Geology of Central Sinano, 1931, pl. XIV, fig. 4 (figure only).
- 5) S. ENDÔ: A Pleistocene Flora from Siobara, Japan. Sci. Rep., Tôhoku Imp. Univ., 2nd Ser., vol. XXI, no. 1, 1940, p. 68, pl. IV, fig. 1; pl. VIII, figs. 7, 19.
- 6) A. G. NATHORST: Contribution à la flore fossile du Japon. Kgl. Svensk. Vet. Akad. Handl., vol. XX, no. 20, 1883, p. 63, pl. I, fig. 12.
- 7) R. FLORIN: Op. cit., 1920, p. 33, pl. V, figs. 16, 17.
- 8) R. FLORIN: Ibid., p. 33, pl. VI, figs. 19, 19a.
- 9) E. KON'NO: Op. cit., 1931, pl. XIV, fig. 5 (figure only).
- 10) A. G. NATHORST: Op. cit., 1888, p. 31, pl. VII, fig. 13.
- 11) T. SHIKAMA: Kôbe Group and Its Flora. Journ. Geol. Soc. Japan, vol. XLV, no. 539, 1938, p. 630 (list only).

Tyôsen:

- T. sp.* TATEIWA (list only).¹⁾ Ryûdo Formation in the Meisen District.
- T. cfr. cordata* MILL. (list only).²⁾ Kantindô Formation in the Meisen District.
- T. Maximovicziana* SHIRASAWA (list only).³⁾ Kantindô Formation in the Meisen District; Tûsen coal-mine,⁴⁾ Kôgen-Do.
- T. Miqueliana* MAXIM. (list only).⁵⁾ Kantindô Formation in the Meisen District.
- ***T. distans* NATHORST.
- ***T. japonica* SIMK.
- ***T. remotiserrata* sp. nov.
- ***T. subnobilis* HUZIOKA sp. nov.
- ***T. meisenensis* sp. nov.

China:

- T. miochinensis* HU and CHANEY⁶⁾. Shanwang, Prov. Shantung, Miocene.
- T. miohenryana* HU and CHANEY⁷⁾. Do.
- T. preamurensis* HU and CHANEY⁸⁾. Do.
- T. sp.* HU and CHANEY⁹⁾. Do.
- T. cordata* MILL. Buchtorma¹⁰⁾, Altai Mountainrange. Probably Pliocene.

** See K. HUZIOKA: Notes on Some Tertiary Plants from Tyôsen. I. This number of this Journal, pp. 117-141.

- 1) I. TATEIWA: Geological Atlas of Tyôsen, No. 4. Kyokudô-Meisen-Shichihôsan and Kôtendo Sheets, 1/75000, 1925.
- 2) S. ENDÔ: Cenozoic Plants from Tyôsen (Korea). I. Journ. Geol. Soc. Japan, vol. XLV, no. 532, 1938, p. 86 (list only).
- 3) Ditto.
- 4) S. ENDÔ: Cenozoic Plants from Tyôsen, II. Ibid., vol. XLV, no. 534, 1938, p. 326 (list only).
- 5) S. ENDÔ: Cenozoic Plants from Tyôsen, I. Ibid., p. 86 (list only).
- 6) H. H. HU and R. W. CHANEY: A Miocene Flora from Shantung Province, China. Carnegie Inst. Wash. Publ. no. 507, 1940, p. 68, pl. XLV, figs. E, 8.
- 7) H. H. HU and R. W. CHANEY: Ibid., p. 69, pl. XXXIII, fig. 3a; pl. XLIV, figs. 1, 2; pl. XLV, figs. 3.
- 8) H. H. HU and R. W. CHANEY: Ibid., p. 70, pl. XLV, figs. 1, 4; pl. L, fig. 1.
- 9) H. H. HU and R. W. CHANEY: Ibid., p. 70, pl. XLV, fig. 2.
- 10) J. SCHMALHAUSEN: Ueber tertiær Pflanzen aus dem Thale des Flusses Buchtorma am Fusse des Altaigebirges. Palaeontogr., vol. XXXIII, 1887, p. 211, pl. XXII, figs. 1-4.

The criteria of determination of fossil *Tilia* hitherto described from various parts of the world were chiefly based upon impressions of leaves which sometimes make it difficult to identify them as being true representatives of this plant in the geological history. In rare cases there occur floral bracts which though not always perfectly preserved present peculiar morphological characters by which they can easily be distinguishable from similar organs in any other groups of living and fossil plants. Therefore in this latter case the determination, at least the determination of the generic position, is to a considerable degree available. Generally speaking, the leaves of modern *Tilia* appear to show limited variation in their morphological characters, especially in regards to their general outline, characteristic marginal serration, nervation, etc. In rare cases the margin is entire as in *T. mofungensis* CHUN and WONG living in southern China.

The specimens of fossil *Tilia* which the present writers dealt with in the present paper are unfortunately fragments of leaves in addition to some imperfect floral bracts, yet the former bears morphological features characteristic to leaves of modern *Tilia*; therefore there may be little doubt at least of their generic determination. The fossil *Tilia* from Hokkaidô and Karahuto now the present writers discriminated contains only two different types which they wish to call under the new specific names, namely, *T. harutoriensis* and *T. remotiserrata*. Besides these, there are some fragments of leaves and floral bracts which can hardly be specifically determinable. *T. harutoriensis* has been derived from the Harutori Bed (Lower Urahoro Series; Urahoroian) of the Harutori coal-mine in the Kusiro coal-field and it is, as far as the present writers know, the oldest representative of the genus in the eastern Asiatic region. *T. remotiserrata* is species having minutely serrate margin and is closely related to certain species of modern *Tilia* such as *T. kwangtungensis* CHUN and WONG, *T. begoniifolia* CHUN and WONG, and some others growing in central and southern China; this fossil species has been derived from the Esutoru coal-bearing bed (Kawabataian) of Nayosi, Karahuto. Thus it should be noticed from the view point of palaeophytogeography that the fossil *Tilia* of the Kawabataian of Karahuto is, so far as the morphological features of the leaves are concerned, closely related to the modern species now growing in southern China (N. L. 25°–35°). Some fragmentary leaves and bracts from Abura (Kunnui Series; Kawabataian), Prov. Siribesi, Hokkaidô, has been described as *T. spp.* in the present paper.

Outside Hokkaidô and Karahuto, fossil *Tilia* has been recorded under several specific names from various parts of Honsyû, Kyûsyû, Tyôsen and adjacent land (China) as listed above, but some of them are specifically hardly determinable or only listed with neither figures nor description. Unfortunately our knowledge on the Cenozoic plants of Eastern Siberia is at present poor. But the literature available at hand shows that this genus is very poorly represented in the Cenozoic deposits in that district.

In Hokkaidô and Karahuto, the geological occurrence of the genus *Tilia* is also almost confined to the Kawabata Series and its equivalents except one from the Urahoro Series in the Kusiro coal-field, Hokkaidô, and there is no fossil record of the genus from the Palaeogene and the rocks earlier than this. Even the Palaeogene coal-bearing rocks so widely developed in northern Kyûsyû do not yield a single fragment which may be referable to the genus *Tilia*. This fact may suggest that *Tilia* began to occupy an element of Miocene and Pliocene forests in the Eastern Asiatic regions since the beginning of approximately Miocene age.

Description

Tilia harutoriensis sp. nov.

Pl. VIII(I), Fig. 1 (Type specimen).

Description: Leaf petiolate, lamina large roundish in outline, about 12 cm. length, about 11 cm. in width. Apex unknown. Base cordate, with slightly decurrent lamina. Margin serrate; marginal teeth rather regular, shallow but acute. Midvein prominent, thick, straight, persisting to the apex; lateral primary veins about 8 in number on each side of midvein with which they make an angle of about 35°, curving gently, reaching the margin of the leaf, the lowest pair of the lateral veins subpalmate at the base with the midvein, slightly decurrent below and gives off about 6 secondary veins abaxially terminating in teeth.

Remarks: The single figured specimen examined. Though the whole outline is unknown, the leaf seems to be slightly asymmetrical at the base. The apex is also unfortunately broken.

Comparison: Among the living *Tilia*, *T. japonica* SIMK.¹⁾ and

1) Japan (Hokkaidô, Honsyû, Sikoku and Kyûsyû) and China (Kiangsu, Anhwei, Chekiang).

T. nobilis REHDER et WILSON¹⁾ resemble more or less the present fossil. But the fossil shows more strong resemblance to the fossil forms such as *T. Malmgreni* HEER²⁾ from the circum polar region, *T. alaskana* HEER³⁾ and *T. notabilis* HOLLICK⁴⁾ from Alaska and *T. aspera* (NEWB.) LAMOTTE⁵⁾ from North America. Of these, the three but the last one are somewhat fragmentary to admit comparison. Especially *T. alaskana* is doubtfully tiliaceous. *T. aspera* has long been passed as *Platanus aspera*. But recently LAMOTTE selected among NEWBERRY's material true tiliaceous leaves which she called *Tilia aspera* (NEWB.). *T. aspera* thus defined shows very close resemblance with the present species, but in the American species the base of the leaf is more strongly cordate and the lateral primary veins are more in number. Otherwise the two appear to be almost indistinguishable.

Occurrence: Harutori coal-mine,* Kusiro City, Prov. Kusiro, Hokkaidô. Harutori Bed (Lower Urahoroian); rare; coll. K. HUZIOKA.

Tilia remotiserrata sp. nov.

Pl. VIII(I), Figs. 2, 2a (Type-specimen).

Description: Leaf small, ovate in outline, about 6 cm. long, 3 cm. broad. Apex acuminate. Base deeply cordate, oblique and asymmetrical. Margin except basal portion finely serrate. Venation indistinct. Midvein distinct and straight. Lateral primary nerves about 5 pairs on each side, at a narrow angle to the midvein, nearly straight, or slightly ascending especially in those which stand from the base and end in marginal teeth. Lateral secondaries are given off from the lowest pair of the primaries and curve strongly upwards forming loope (camptodromous) at the margin. Lateral tertiaries obscure.

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- 1) China (Szechuan).
 - 2) O. HEER: Flora Fossilis Arctica, Bd. I, Abth. 5, 1868, p. 160, pl. XXXIII.
 - 3) O. HEER: Ibid., Bd. II, Abth. 2, 1869, p. 36, pl. X, figs. 2, 3.
 - 4) A. HOLLICK: Tertiary Floras of Alaska. U. S. G. S. Prof. Paper, 182, p. 936, p. 145, pl. LXXXII.
 - 5) R. S. LAMOTTE: The Miocene *Tilias* of Western America. Carnegie Inst., Washington, Publ., no. 455, 1936, p. 45, pl. I, figs. 1-3; pl. II, figs. 1, 2.

* 北海道釧路國釧路市春採炭礦。浦幌統春採層。

Remarks: The above description is based on the specimen in fig. 2, the type-specimen. There is one more leaf impression occurred in association with the type-specimen, but it is imperfect. The marginal serration is shown in fig. 2a. The lamina of the leaf seems to be thick textured.

Comparison: There is no identical or even comparable fossil leaves with the present specimens. While on the contrary, it is highly interesting that there is a number of Chinese living species which show striking resemblance with the present fossil; they are *T. leptocarya* REHDER¹⁾, *T. lepidota* REHDER²⁾, *T. begoniifolia* CHUN and WONG³⁾, *T. Tuan* SYSZYL⁴⁾, *T. oblongifolia* REHDER⁵⁾ and *T. mofungensis* CHUN and WONG⁶⁾. Of these, *T. lepidota* has leaves very similar to the present fossil. However, in the former, the margin of the leaves is almost entire or rarely serrate, while in the latter the lamina is broader and its margin is almost entire. Finally, there is no Japanese modern *Tilia*, the leaves of which are comparable to the present fossil.

Occurrence: Nayosi,* Nayosi-Mati, Nayosi-Gun, Karahuto. Esutoru coal-bearing Bed (Honto Series; Kawabataian); rare; coll. R. HUKAYA.

Tilia spp.

Pl. VIII(I), Figs. 3-6.

Besides the two different types of leaves described above, there are some other leaves bearing morphological features of *Tilia* type, together with a few number of floral bracts occurred in close association with the leaves. They are however all fragmentary and specifically hardly determinable.

Description: Fig. 3 shows basal part of a leaf. It is cordate at the base, with dentate margin, and the venation is prominent, the lateral primary veins being at an angle of about 60° with the mid-vein, curving somewhat upwards, secondaries are also well-defined. Three types of floral bracts are shown in figs. 4, 5 and 6. One in

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- 1) Southern Chekiang and southern Anhwei.
 - 2) Southern Chekiang.
 - 3) Kwangtung.
 - 4) Kiangsu, Kiangsi, Hupeh, Szechuan, Kueichow, Kwangsi.
 - 5) Anhwei.
 - 6) Kwangtung.

* 樺太名好郡名好町名好. 本斗統惠須取夾炭層.

fig. 4 is more than 5 cm. long and 1.5 cm. broad, one in fig. 5 is 5 cm. long and 1.2 cm. broad, while the one in fig. 4 attains 2 cm. in breadth though imperfect in both ends. In the bract in fig. 4 the lateral veins are nearly perpendicular to the midvein, while in those in figs. 5 and 6 they are oblique.

Remarks: There are a number of living *Tilia* resembling the present fossil specimens; they are *T. Miqueliana* MAXIM.¹⁾, *T. mandshurica* REHDER and MAXM.²⁾ and *T. amurensis* RPR.³⁾ But the fossils are too imperfect to admit precise comparison with those living species. Among fossil leaves, *T. sachalinensis* HR.⁴⁾ from Sachalien seems to resemble the present fossil shown in fig. 1, but in the former the base is strongly oblique, and the lateral primary veins make a wide angle with the midvein.

Occurrence: Abura,* near Setana, Prov. Siribesi, Hokkaidô. Kunnui Series (Kawabataian); rare; coll. S. ÔISHI and S. HANADA.

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- 1) Japan (Kyûsyû?) and China (Kiangsu).
 - 2) Tyôsen, Manchoukuo and China (Hopei, Shantung, Kiangsu).
 - 3) Tyôsen and Manchoukuo.
 - 4) O. HEER: Primitiae Florae Fossilis Sachalinensis. Flora Fossilis Arctica, vol. V, Abt. 3, 1878, p. 47, pl. XII, figs. 6, 7.

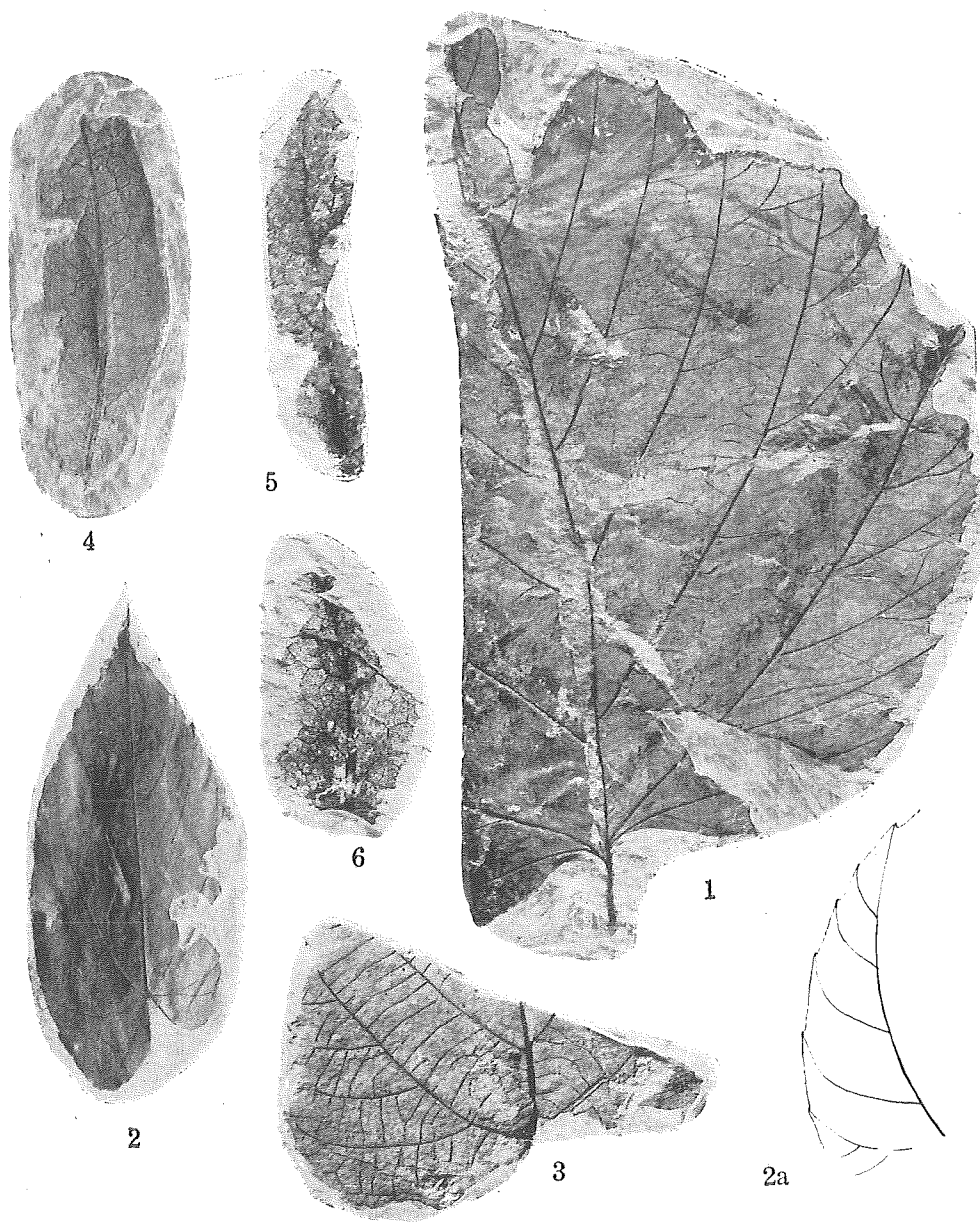
* 北海道後志國瀬棚郡瀬棚町虻羅。訓縫統。

EXPLANATION OF THE PLATE

(The figures are of natural size)

Pl. VIII(I).

- Fig. 1. *Tilia harutoriensis* sp. nov. Harutori coal-mine, Kusiro City, Prov. Kusiro, Hokkaidô. Harutori Bed (Lower Urahoroian).
- Fig. 2. *Tilia remotiserrata* sp. nov. Nayosi, Nayosi-gun, Karahuto. Esutoru coal-bearing bed (Kawabataian).
- Fig. 2a. A sketch of part of margin in fig. 2, showing marginal serration.
- Fig. 3. *Tilia* sp. Abura, Setana-gun, Prov. Siribesi, Hokkaidô. Kunnui Series (Kawabataian).
- Figs. 4, 5, 6. *Tilia* spp. Bracteoles associated with the leaf in fig. 3.



Kumano photo.