

Takasi YAMAZAKI*: **Gamopetalous plants in Far Eastern
Asiatic regions** and Micronesia (1)**

山崎 敬*: 日本周辺**及びミクロネシアの合弁花植物 (1)

The word Gamopetalae may be a collective term for an assemblage of Dicotyledonous plants, which includes only some natural groups. The Gamopetalae should be divided into some phylogenetically separated groups. On the basis of the embryological characters discussed in the previous paper (Yamazaki 1973), four groups are recognized in them, namely the Ericanae, Gentianae, Lamianae and Asteranae, which may be all treated as superorders. This paper presents a systematic arrangement of orders, families and genera of Gamopetalous plants, and a list of the species known as indigenes or as exotics in the Far Eastern Asiatic regions** and Micronesia.

Ericanae. The development of the embryo is assigned to the Polygonad type and rarely to the Solanad one (the Plumbaginaceae and some members of the Boraginaceae). The early endosperm formation is usually of the Nuclear type, but some members have the Cellular one as in the Diapensiales and the Ericales. The endosperm has usually no haustorium except the Ericales, which have conspicuous haustoria. The ovary is 3-5- or sometimes 8-12-locular in the Ebenales, and is 1-locular in the Primulales and the Plumbaginales and is usually superior, though rarely inferior in the Symplocaceae. The stamens are usually two times as many as the petals in one or two whorls, or numerous as in the Symplocaceae and the Sapotaceae, sometimes reduced to the same numbers as or less than the petals. The corolla is 4-5- rarely 3-merous, regular.

This Superorder consists of seven orders; Ebenales, Diapensiales, Ericales, Oleales, Primulales, Plumbaginales and Polemoniales. They are distinguished each other as follows:

A. Stamens arranged in 2-4 whorls, or in one whorl opposite to the sepals;

* Botanical Garden, Faculty of Science, University of Tokyo. 東京大学理学部附属植物園

** The regions are restricted in Manchuria, Korea, Sakhalin, Japan, Ryukyu and Taiwan.

- ovary 2-10-locular with axile placenta, rarely 1-locular with parietal placentas.
- B. Stamens free from the petals, 1-2-whorled; ovary 3-7-locular, with many ovules on axile placenta (one ovule in the Empetraceae).
 Ericales
- B. Stamens inserted on the petals.
- C. Stamens 2-4 times as many as the petals, arranged in 1-4 whorls (the same numbers as the petals in *Diapensia*); ovary 3-10-locular (2-locular in some members of the Symplocaceae).
- D. Stamens arranged in 2-4 whorls; ovary 2-10-locular; trees.
 Ebenales
- D. Stamens typically 2-whorled; the outer antisepalous one often reduced to the staminodes or absent; ovary 3-locular; shrubs. . .
 Diapensiales
- C. Stamens as many as or less than the petals, in one whorl; ovary 2-3-locular.
- D. Flowers generally tetramerous, sepals 4, petals 4 and stamens 2 (both sepals and petals 5 or more in *Jasminum*); ovary 2-locular; trees.
 Oleales
- D. Flowers generally pentamerous, sepals 5, petals 5 and stamens 5; ovary 2-3-locular; trees, shrubs or herbs.
 Polemoniales
- A. Stamens arranged in one whorl, opposite to the petals; ovary 1-locular with a basal or free-central placenta.
- B. Stamens inserted on the petals; stigma capitate; ovary with numerous ovules on a free-central placenta.
 Primulales
- B. Stamens free from the petals or inserted on them; stigma deeply 5-lobed; ovary with a solitary basal ovule.
 Plumbaginales

Ebenales. Trees. Leaves alternate, simple, often leathery. Flowers regular, 4-5-merous; petals united. Stamens 2-3 times as many as the petals, 2-3-whorled, inserted on the petals. Ovary superior to inferior, 2-12-locular, with one to a few ovules in each locule, pendulous on axile placenta. Ovules with one or two integuments. Fruit a drupe, berry or capsule. Seeds one to a few with massive hard or thin membranaceous testa. Endosperm copious or absent.

This Order consists of four families; Sapotaceae, Ebenaceae, Stylacaceae and Symplocaceae. They are distinguished each other as follows:

- A. Ovary superior or half-inferior, 3-12-locular; stamens 1-2 times as many as the petals, 1- or 2-whorled; fruit a berry or drupe; seeds usually with a massive hard testa or rarely thin membranaceous one.
- B. Ovary superior, completely septate, 4-12-locular, with one or rarely two ovules in each locule; fruit a berry; plants usually without stellate hairs.
- C. Stems and leaves with milky juice; flowers bisexual; ovule with one integument; endosperm copious, eruminate; embryo large, as long as the endosperm, with a short hypocotyl and large foliaceous cotyledons. Sapotaceae
- C. Stems and leaves lacking milky juice; flowers usually unisexual, rarely bisexual; ovule with two integuments; endosperm copious, often ruminant; embryo shorter than the endosperm, with a long hypocotyl and foliaceous cotyledons. Ebenaceae
- B. Ovary superior or half-inferior, incompletely 3-5-locular, completely septate only in the lower portion, with 2-4 ovules in each locule; ovule with two integuments; fruit a drupe, with a fleshy or dry coat, indehiscent, often splitting by three valves, rarely with a septicial 5-valved capsule; endosperm copious; embryo large, as long as the endosperm, with a long hypocotyl and large foliaceous cotyledons; plants covered with stellate hairs. Stylacaceae
- A. Ovary inferior, 2-5-locular; stamens numerous, irregularly arranged or 5-fasciculed; ovule with one integument; fruit a drupe, with a hard mesocarp and fleshy pericarp; seeds with a thin testa; embryo large, as long as the endosperm, with a large curved or straight thickend hypocotyl and small cotyledons. Symplocaceae

From the embryological viewpoint these four families are distinguished each other as follows:

- A. In the early development of the embryo the directions of the cell-divisions are relatively irregular. The young embryo has a massive suspensor.
- B. The ovule has a thick integument. The mature embryo sac is tri-

- angular in shape. The endosperm formation is of the Nuclear type but later the tissue becomes cellular throughout; a large vacuole appears near the center of the young endosperm. The very young embryonal mass often has a lateral embryonal branch. . . Sapotaceae
- B. The ovule has two integuments. The mature embryo sac is narrowly oblong in shape. The endosperm formation is of the Cellular type, in early stage the endosperm cells have a tendency to be arranged in a linear row of four or six tiers composed of one or two cells. The young embryonal mass is not branched. Ebenaceae
- A. In the early development of the embryo the directions of the cell-divisions are relatively regular. The young embryo has a slender suspensor. The mature embryo sac is linear in shape. The endosperm formation is of the Cellular type.
- B. The ovule has two integuments. The mature embryo has two large cotyledons and a thickened hypocotyl. Stylacaceae
- B. The ovule has one integument. The mature embryo has small cotyledons and an elongated hypocotyl. Symlocaceae

Sapotaceae

Trees or shrubs, with milky juice; the branchlets and young shoots often ferruginous-tomentose. Leaves alternate, simple, entire, leathery, stipulate or often with caducous stipules. Flowers solitary or more commonly in cymose clusters in the leaf axils or above the scars of fallen leaves, bisexual. Calyx free and persistent, 4-8 in two isomerous whorls or five in one whorl. Petals united at the base, the lobes usually as many as the sepals, imbricate, sometimes with paired lateral or dorsal appendages. Stamens usually 2-3 times as many as the petals, often the outer antisepalous whorl reduced to staminodes or entirely absent. Ovary superior, 4-12-locular, with a single ovule in each locule, situated at the base of the axile placenta. Style linear; stigma small. Ovules anatropous, with one integument. Fruit a berry, with one to a few seeds. Seeds with hard lignified testa. Endosperm copious or thin, often absent. Embryo large, as long as the endosperm, with a short hypocotyl and large foliaceous cotyledons. The endosperm formation is of the Nuclear type but later the tissue becomes cellular throughout; a large vacuole appears near the center of the young

endosperm. The development of the embryo is assigned to the Polygonad type.

In the treated area four genera of six wild and two cultivated species are known.

A. Sepals 6-8, in two isomerous whorls; stamens two times as many as the petals.

B. Sepals 6; stamens 6-8; staminodes absent; ovary 6-locular. *Palaquium*

B. Sepals 8; fertile stamens 6, one outer antisealous whorl reduced to 6 staminodes; ovary 10-12-locular. *Manilkara*

A. Sepals 5 in one whorl; stamens 5; staminodes small or absent; ovary 5-locular, rarely 4- or 6-locular.

B. Androecium with one whorl of five fertile stamens and one of five sterile ones. *Planchonella*

B. Androecium with one whorl of five fertile stamens; sterile stamens absent. *Chrysophyllum*

Tribe **Palaquiinae** Engler in Bot. Jahrb. 12: 508 (1890) ut Palaquieae, Engler's Pflanzenfam. IV-1: 131 (1897) sensu emend.

Subfam. Madhucoideae Lam in Meded. Bot. Mus. Rijksksherb. Utrecht 65: 525 (1939).

Subtribe **Palaquieae** Lam in Bull. Jard. Bot. Buitenz., ser. III, 7: 14 (1925).

Palaquium Blanco, Fl. Phillip. ed. 1, 403 (1837).

Trees. Stipules caducous, rarely persistent. Inflorescences fasciculate, axillary. Flowers trimerous. Calyx free and persistent, in two isomerous whorls, the outer three valvate, the inner three imbricate. Corolla 6-lobed, the lobes united at the base, imbricate. Stamens 12-18, in two or three whorls, inserted in the throat; anthers with a prolonged connective. Ovary 6-locular, with one ovule in each locule. Fruit a berry, 1-3-seeded. Seeds with a large scar which often covers half of the surface, usually without endosperm.

About 115 species in India, Indo-China, Malaysia and the Pacific islands, two species in the treated area.

A. Leaves 18-28 cm long, 10-14 cm broad; petioles 3-5 cm long, glabrous;

flowers 1 cm across. *P. karrak*
 A. Leaves 10-15 cm long, 5-7 cm broad; petioles 0.3-0.7 cm long, ferruginous-tomentose; flowers 2.5 cm across. *P. formosanum*
Palaquium karrak Kanehira in Bot. Mag. Tokyo, 45: 339 (1931) et Fl. Micronesia, 304, f. 153 (1933), van Royen in Blumea, 10: 549 (1960).

Distr. Micronesia: Isls. Carolin, Ponape.

Palaquium formosanum Hayata, Mat. Fl. Formos., 184 (1911), van Royen, l. c., 472 (1960), Liu, Ill. Lign. Pl. Taiwan, 1012, f. 839 (1962), Li, Woody Fl. Taiwan, 725, f. 295 (1963).

Distr. Taiwan (Isl. Botel-Tobago) and Philippines.

Tribe **Sapotinae**

Tribe Mimosopeae
 Engler in Bot. Jahrb., 12: 496 (1890) et Pflanzenfam., IV-1: 150 (1897) sensu emend.

Subfam. Mimosopoi-deae Lam in Meded. Bot. Mus. Rijksksherb. Utrecht, 65: 524 (1939).

Subtribe **Sapoteeae**

Subtribe Manilkareae
 Lam in Bull. Jard. Bot. Buitenz., ser. III, 7: 14 (1925).

Manilkara Adanson, Fam. Pl., 2: 166 (1763) nom. cons., Gilly in Trop.

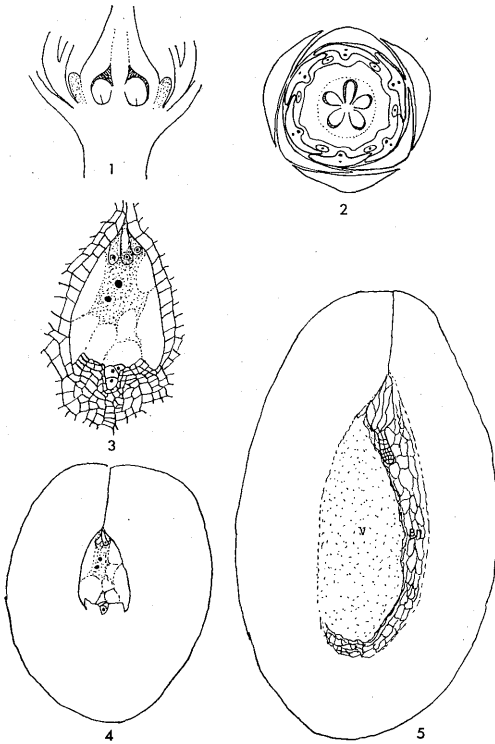


Fig. 1. *Planchonella obovata*: 1. Flower, in vertical section $\times 8$. 2. The same, in cross section $\times 8$. 3. Embryo sac $\times 230$. 4. Ovule, in vertical section $\times 110$. 5. Young seed, in vertical section to show young endosperm with a large vacuole $\times 50$. v: vacuole. en: endosperm.

Woods, 73: 8 (1943), van Royen in Blumea, 7: 401 (1953).

Achras L., Sp. Pl., ed. 1, 1190 (1753).

Northiopsis Kanehira in Bot. Mag. Tokyo, 47: 677 (1933).

Trees. Stipules caducous. Flowers cymose in the leaf axils. Calyx with two whorls of three lobes each, persistent, the outer ones valvate, the inner imbricate. Corolla 6-lobed, the lobes with two dorsal segments or without segments, imbricate. Stamens as many as the petals, opposite to them, epipetalous, inserted in the row of the staminodes. Anthers sagittate with a prolonged connective. Staminodes 6, petaloid or subulate, alternating with the stamens. Style linear; stigma entire. Ovary 6-12-locular, with a single ovule in each locule. Fruit ellipsoid to globose, fleshy, several-seeded. Seeds with a long lateral scar. Endosperm abundant.

About 75 species in the tropics of both hemispheres; three species in the treated area, two native and the other one cultivated.

- A. Petals with dorsal appendages..... Subgen. *Manilkara*
 *M. udoido*
- A. Petals without appendages Subgen. *Euachras*
- B. Staminodes large petaloid; corolla tubular; ovary 12-(sometimes 6-10-)
 locular *M. zapota*
- B. Staminodes subulate; corolla lobed near the base, the lobes narrowly
 lanceolate; ovary 6-locular *M. hoshinoi*

Subgen. **Manilkara**

Subgen. *Eumanilkara* (Dubard) Gilly, l. c., 9 (1943).

Manilkara udoido Kanehira in Bot. Mag. Tokyo, 47: 677 (1933), Kanehira, Fl. Micronesia, 304, f. 154 (1933).

Distr. Micronesia: Isls. Carolin, Palau.

Subgen. **Euachras** Gilly, l. c., 17 (1943).

Manilkara zapota (L.) van Royen in Blumea, 7: 410 (1953).

Achras zapota L., Sp. Pl., ed. 1, 1190 (1753), Liu, l. c., 1011, f. 838 (1962).

Manilkara zapotilla (Jacq.) Gilly, l. c., 20 (1943).

Distr. A native of South America, cultivated throughout the tropics (incl. Taiwan and Ryukyu).

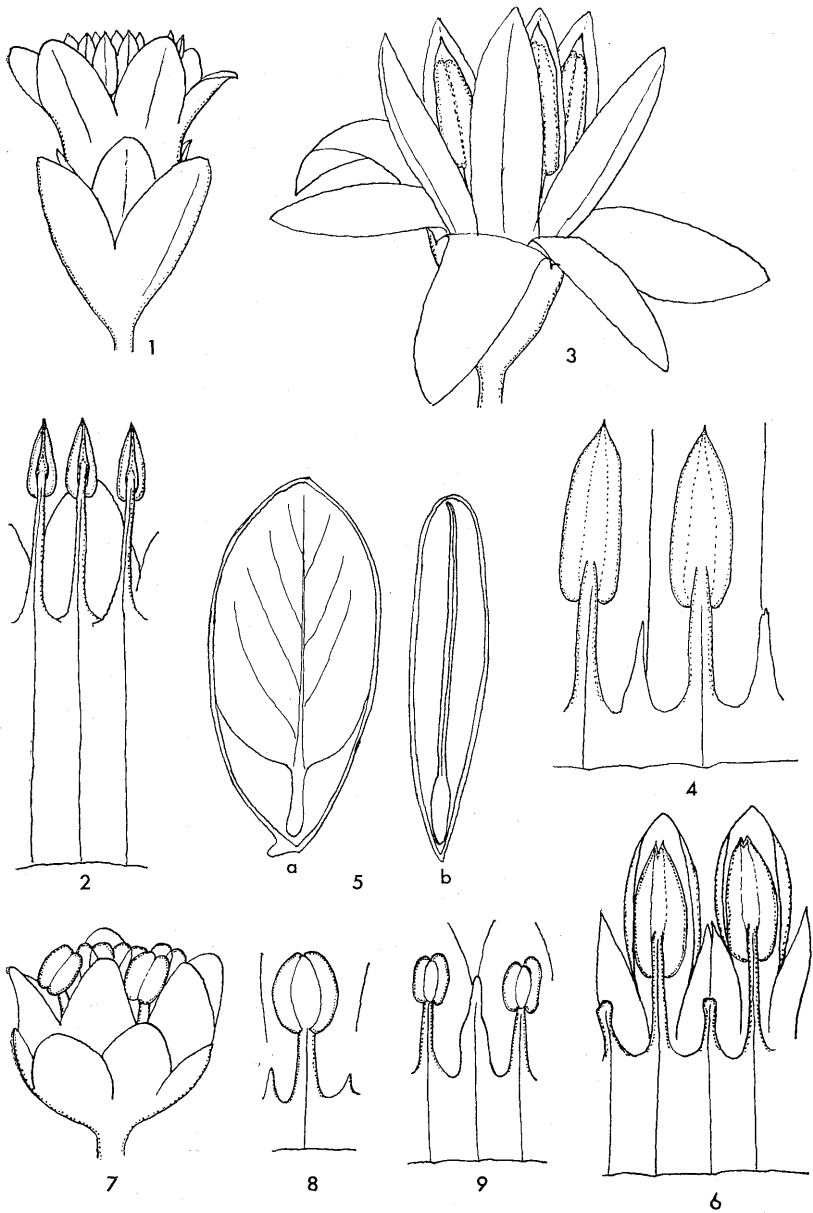
Manilkara hoshinoi (Kanehira) van Royen, l. c., 410 (1953).

Northia hoshinoi Kanehira in Bot. Mag. Tokyo, 46: 489 (1932).

Northiopsis hoshinoi (Kanehira) Kanehira, Fl. Micron., 302 (1933).

Distr. Micronesia: Isls. Carolin, Ponape.

Tribe **Sideroxylinae** Dubard in Ann. Mus. Col. Marseille, 20: 1 (1912),



Lam in Bull. Jard. Bot. Buitenz., ser. III, 7: 190 (1925).

Subfam. Sideroxyloideae Lam in Meded. Bot. Mus. Rijksksherb. Utrecht, 65: 524 (1939).

Subtribe **Sideroxyleae** Engler in Bot. Jahrb., 12: 508 (1890) ut Sideroxylinae.

Planchonella Pierre, Not. Bot. Sapot., 34 (1890), van Royen in Blumea, 8: 235 (1957).

Pouteria Aublet sensu Baehni in Candollea, 9: 149 (1943) pro parte.

Trees or shrubs. Stipules absent or early caducous. Flowers 5-merous, solitary, or a few in clusters in the leaf axils. Sepals 5, free, imbricate. Corolla campanulate, 5-lobed, imbricate. Stamens 5 in one whorl, inserted on the corolla-tube. Staminodes 5, small, lanceolate, alternating with the stamens; anthers basi-fixed, without a prolonged connective. Ovary 5-locular, with one ovule in each locule. Fruit a berry, 1-6-seeded. Seeds with a long narrow scar. Endosperm copious.

About 100 species in southeastern Asia, Malaysia, Australia and the Pacific islands; three natives in the treated area.

A. Leaves glabrous on both surface.

B. Leaves oblong, 15-21 cm long, 7-9 cm broad, acute at apex; fruit oblong to orbiculate-ellipsoid, 1 cm long, 0.7-1 cm broad. *P. micronesica*

B. Leaves oblong-obovate, obtuse to rounded at apex, 7-15 cm long, 3.5-9 cm broad; fruit ellipsoid, 4.5 cm long, 3.5-4 cm broad... *P. boninensis*

A. Leaves white- or ferrugineous-sericeous beneath, oblong, oblong-obovate to orbicular-obovate, obtuse at apex, 3-14 cm long, 1-6 cm broad; fruit ellipsoid, 1-1.5 cm long, 0.7-1 cm broad. *P. obovata*

Planchonella micronesica (Kanehira) Kanehira ex Lam in Blumea, 5: 12 (1942), van Royen in Blumea, 8: 402, f. 45 (1957).

Sideroxylon micronesicum Kanehira in Bot. Mag. Tokyo, 46: 671 (1932) et Fl. Micron., 308, f. 156 (1933).

Fig. 2. Sapotaceae: 1-2. *Palaquium karrak*. 1. Flower $\times 3$. 2. A part of corolla viewed from inside $\times 5$. 3-4. *Manilkara hoshinoi*. 3. Flower $\times 2$. 4. Stamens and staminodes viewed from inside $\times 3$. 5. *Manilkara zapota*. Seed, sections in two different directions. a: vertical section parallel to the flattened surface. b: vertical section at right angle with the fig. a $\times 7$. 6. *Manilkara udoid*. A part of corolla viewed from inside, showing stamens, staminodes and appendages $\times 7$. 7-8. *Planchonella obovata*. 7. Flower $\times 5$. 8. Stamen and staminodes viewed from inside $\times 8$. 9. *Planchonella boninensis*. Stamens and staminode viewed from inside $\times 8$.

- Distr. Micronesia: Isls. Carolin, Kusaie.
- Planchonella boninensis** (Nakai) Masamune et Yanagihara in Trans. Nat. Hist. Soc. Formos., 31: 322 (1941).
- Sideroxylon boninense* Nakai in Bot. Mag. Tokyo, 43: 444 (1929).
- Pouteria boninensis* (Nakai) Baehni in Candollea, 9: 311 (1942).
- Distr. Isls. Bonin: Chichizima, Hahazima, Mukozima and Anizima.
- Planchonella obovata** (R. Br.) Pierre, Not. Bot. Sapot., 36 (1890), Hatusima, Fl. Ryukyus, 472 (1971).
- Pouteria obovata* (R. Br.) Baehni, l. c., 324 (1942), Hara, Enum. Sperm. Jap., 1: 100 (1948), Liu, Ill. Lign. Pl. Taiwan, 2: 1013, f. 840 (1962), Li, Wood. Fl. Taiwan, 727, f. 297 (1963).
- Sideroxylon liukiunense* Nakai in Bot. Mag. Tokyo, 33: 209 (1919).
- Sersalisia liukiunensis* (Nakai) Nakai in Bull. Tokyo Sci. Mus., 22: 31 (1948).
- Sideroxylon glomeratum* Volkens in Engl. Bot. Jahrb., 31: 472 (1901), Kanehira, Fl. Micron., 307, f. 155 (1933).
- Distr. Throughout the tropics in southeastern Asia (incl. Ryukyu and Taiwan), India, Australia and the Pacific Islands.
- Species imperfectly known.
- Planchonella calcarea** (Hosokawa) van Royen in Blumea, 8: 422 (1957).
- Sideroxylon calcareum* Hosokawa in Trans. Nat. Hist. Formosa, 32: 17 (1942). Specimens not seen.
- This is near to *P. micronesica*, but differs from it by the larger fruits.
- Subtribe **Chrysophylleae** Lam in Bull. Jard. Bot. Buitenz., ser. III, 7: 11 (1925).
- Chrysophyllum** L., Sp. Pl., ed. 1, 192 (1753), Vink in Blumea, 9: 21 (1958).
- Chrysophyllum cainito** L., Sp. Pl., ed. 1, 192 (1753), Lam, l. c., 188 (1925).
- Distr. A native of tropical America, cultivated in the tropics (rarely in Ryukyu).

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合弁花類は一般に花卉がゆ着している他に、珠皮が一枚であることや、胚嚢の上部をおおう珠心が一層であることなど共通している。しかし系統はかなり複雑で、離弁花類の群に対応するいくつかの系統を異にする群があり、それぞれの群の進化の先端にあるのが合弁花類であり、進化した性質として上記のような共通の特徴をもつのだと考えられる。

胚形成の様式、胚乳形成のしかた、子房の構造などを主として合弁花類は大きく4群に分けることができる。ツツジ上目 *Ericanae*、リンドウ上目 *Gentiana*、シソ上目 *Lamiana*、キク上目 *Asteranae* の4群はそれぞれ大きな共通する特徴をもち、別個の系統のものと見られる。これらの上目が離弁花類のどのような群と対応するかが次の問題となるが、ここではこれら上目にどのような目、科が属するかを明らかにすると共に、日本周辺、ミクロネシアに分布する各種類の系統上の位置を示そうと思う。

アカテツ科はアジア、アフリカ、アメリカの熱帯に分布し、日本ではあまりなじみのない科である。琉球、小笠原にアカテツ、小笠原にムニンノキがあるほか、琉球、台湾でときにサボジラやカイニットが栽培される。

属の分類は主に雄しべの配列のしかた、種子の附着点の形、花弁の背面にある附属体、仮雄蕊、胚の形などが特徴とされる。属の限界のはっきりしないものが多く、人によってかなり意見が異っている。

熱帯に広く栽培されるサボジラ *Manilkara zapota* は、*Achras zapota* の名が広く用いられている。*Achras* は花弁の背面に附属体がないことが特徴とされていた。Gilly (1943) は花の構造の研究から、花弁の背面に附属体をもつ *Manilkara* との間に、中間形があつて連続することから、同一属とすべきだとした。この見解は現在一般に認められている。金平亮三氏がミクロネシアから新属として報告した *Northiopsis* も、花の構造は *Manilkara* の範囲に入るものである。

アカテツは以前は *Sideroxylon* が使われていた。これは主にアフリカに分布するもので、種子の附着点が円形で、種子の下部に限られているので、現在はアカテツの類からは別属とされている。アカテツ類は Baehni (1942) による、主に南アメリカに分布する *Pouteria* と同一とする見解と、Lam (1925), van Royen (1957) の、主にアジアに分布するものを *Planchonella* として区別する見解とがある。*Pouteria* は種子の附着点は巾が広く、しばしば種子の半ばまで広がり、胚は厚い肥大した子葉をもち、種子の内容の大部分を占め、したがって胚乳はごく僅である。*Planchonella* は種子の附着点は線形で、胚は葉状の子葉をもち、多量の胚乳をもつ。どちらの見解が正しいかは日本では判断のしようがない。Aubréville (1960) は Baehni の *Pouteria* のいくつかの種類を別属にうつしていることなどからすると、現在は *Planchonella* を使っておくほうが、適当のようである。

□Shun-ching Lee: *Forest Botany of China Supplement*. 李順郷: 中国森林植物学続篇。A5, 477 頁, Chinese Forest Association, Taipei (100), Taiwan, China より, 1973 年 11 月発行。\$15.00。李氏は 1934 年に *Forest Botany of China* を出版し、それに変種も含めて 1500 種を記載した。その後発表された新しいものを加えて、4073 種におよぶ中国樹木の種、変種を記載したものである。前書と重複するものの記載ははぶいてある。一部の属には検索がつけられている。中国の樹木をすべて記載しようとした努力は大変なものだったと思う。然し種類の検討がなされていないので、すでに常識となっている異名のもも、正名のものと同様に記載を伴ってのせられているので、使用する際にはこの点を注意する必要がある。また記載がやや簡単であり、学名の出典がのせられていないのは研究者にとって不便である。

(山崎 敬)