CHAPTER 3

TAXONOMIC REVISION

METHODOLOGY

Botanical surveys and collections of plants in Nelumbonaceae and Nymphaeaceae were done for this study during 2002–2007. Voucher specimens and materials collected were investigated and identified to specific level and also rechecked by comparison with the materials deposited at herbaria in Thailand and abroad. Descriptions including the obtained information about their vernacular names and uses, ecology, phenology and distribution are provided. Photographs of the taxa are included. A key to the genera and species is provided.

1. Collecting specimens

1.1 Field surveys and collections of Nelumbonaceae and Nymphaeaceae plants were made throughout the natural wetlands in central, northern, northeastern and southern Thailand.

1.2 The specimens were collected with 4–6 duplicates with flowers or fruits and submitted to the herbaria of Queen Sirikit Botanic Garden, Chiang Mai (QBG), the Forest Herbarium, Bangkok (BKF), the Department of Biology, University of Aarhus, Denmark (AAU) and other herbaria working on the Flora of Thailand for further taxonomic references.

1.3 Photographs were taken in the natural habitats.

1.4 Living materials were collected and grown at Queen Sirikit Botanic Garden (QSBG).

1.5. Dried plant specimens were treated chemically with standard method, mounted on the herbarium sheets and labeled. The first duplicate was deposited in QSBG.

2. Identification

2.1 Morphological characters of each specimen such as habit, colour of leaves, flowers and ecological information, etc., were recorded in the field.

2.2 Previous collections from the following herbaria were investigated (abbreviations of the herbaria follow Index Herbarioum)

- Department of Biology, University of Aarhus (AAU),
- Department of Agriculture, Bangkok (BK),
- The Forest Herbarium, Bangkok (BKF),
- Chiang Mai University Herbarium, Chiang Mai (CMU),
- Royal Botanic Garden, Kew, London (K),
- Queen Sirikit Botanic Garden Herbarium, Chiang Mai (QBG)

2.3 The collected specimens were identified with the aid of relevant taxonomic literature.

2.4 The up-to-date nomenclature of each species was investigated, following the International Code of Botanical Nomenclature (ICBN).

3. Description

3.1. Descriptions of the species were made.

3.2. Taxonomic literature was quoted following the author abbreviations of Brummitt and Powell (1992).

3.3. Ecological and phenological information for each species was added from the literature.

3.4. Voucher specimens were quoted.

3.5. Vernacular names and uses were given based on the field observations and supplemented with information from the literature.

3.6. Photographs of the taxa were taken to illustrate the species.

3.7. Key and description of the species including vernacular names and their uses were made and supplemented with line drawings of various diagnostic organs for all taxa.

4. Anatomical study

4.1. Fresh sample materials were fixed in 70 % formaldehyde acetic acid (FAA) for anatomical studied.

4.2. The samples were then dehydrated in an ethanol/distilled water series to tertiary butyl alcohol (TBA).

4.3. Dehydrated samples were infiltrated with paraffin oil and embedded with parafin blocks before sectioning.

4.4. Sectioning was carried out using a rotary microtome 12-18 μm.

4.5. The thin section of samples were affixed by Haupt's ashesive and 3 % formalin, and left in a slide warmer for about 3 days.

4.6. Slides were stained with safranin-fast green as described in Johansen (1968).

4.7. Specimens were made permanent with canada balsam and retained for future reference.

4.8. Characteristics of leaf, petiole and peduncle was studied using light microscope and stereo microscope.

RESULTS

CHARACTERS OF TAXONOMIC IMPORTANCE

The morphological features in the Nelumbonaceae were variable. The plants were commonly found everywhere from sea level to high altitudes upto 400 m above sea leavel such as Chiang Rai Province. General characters for Thai Nelumbonaceae and Nymphaeaceae are as follows:

NELUMBONACEAE

1. Habit

Nelumbonaceae are aquatic perennial herbs. Rhizomes are branched, repent, forming swollen terminal storage tubers in late growing season.

2. Rhizome

The rhizomes are rootstocks or subterranean stems that grow in the ground. They lie shallowly and are slender in the growth period. They are found deeper 5–15 cm below the surface when forming their fat rhizomes with a bulky appearance that produce new buds. The new buds are white and long and are then called “stolons” (Figure 10). The rhizomes have many joints that branch off. The fibrous roots come out and the leaf and flower-stem emerge above. Each individual leaf and flower-stem rises separately from the root.

The terminal bud of the stolon continues to push through the compact soil and rises to form an internode and a leaf. The internode length varies from 10–24 cm, their length usually varies in with the water depth. The rhizomes have big air canals inside. The number of air pipes is mostly 9–12 (Figure 11). Among the air canals there are many vascular bundles that gather to make threads called the lotus threads.

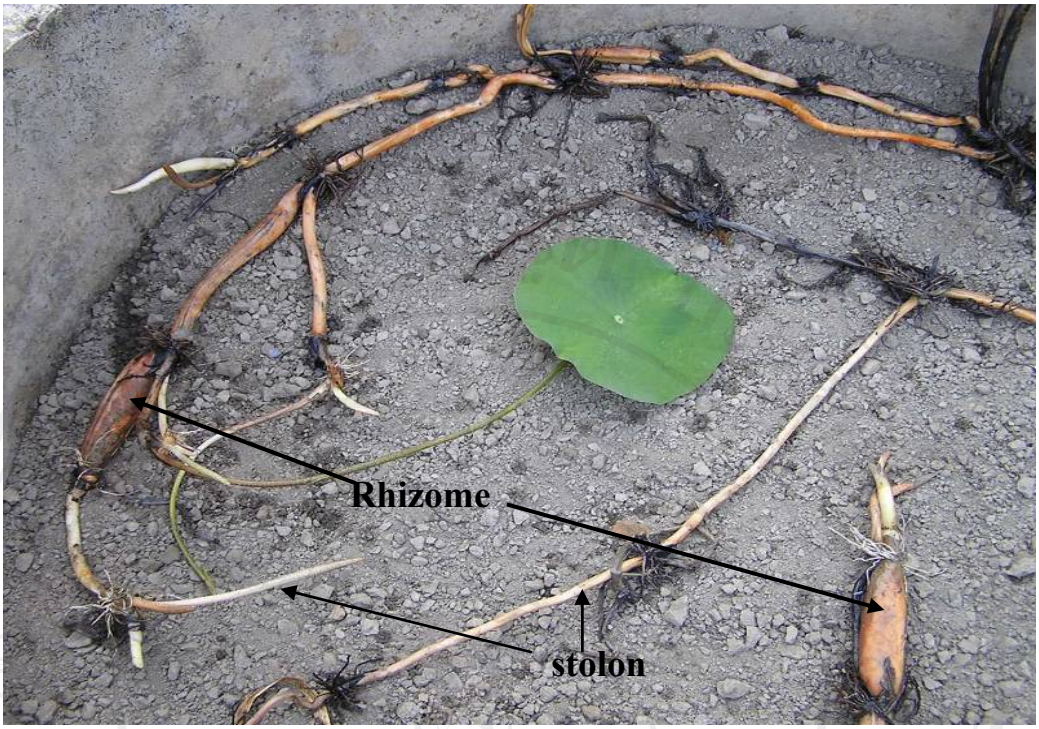

Figure 10. Rhizome of *Nelumbo nucifera* Gaertn. with stolon and root.

Figure 11. Rhizome of *Nelumbo nucifera* Gaertn., showing the big air canals inside.

3. Root

The roots of lotus are fibrous and adventitious and produced in abundance at the nodes of the rhizome. The root system is entirely adventitious since a functional primary root does not develop from the seed. The roots are 3 mm in diam. and 4–15 cm in length (Figure 12). The root of the lotus does not function as a vegetative reproductive structure, as is true for certain other aquatics.

Figure 12. The root of *Nelumbo nucifera* Gaertn. at the node.

4. Leaves

The leaves simply consist of the leaf-blade and the petiole. The long petiole arises directly from the rhizome with a unique phyllotaxy. The phyllomes are distributed in three sets: one foliage leaf and two cataphylls along the rhizome, one cataphyll on the lower side, one on the upper side and immediately subtending the foliage leaf. The foliage leaves are orbicular in shape and centrally peltate. The color is blue-green on their upper surfaces and pale gray beneath. The leaves arise from the upper side of the rhizome; the lower cataphylls are sheathing, with overlapping margins, curved upwards distally, initially wrapped around the petiole and the terminal bud, but ruptured by continued growth of the rhizome; the upper cataphyll is wrapped around the petiole of the subtended foliage leaf (Figure 13). On the surface of the leaf there are many small papilae about 10 microns long that repel the water (Barthlott and Neinhuis, 1997)

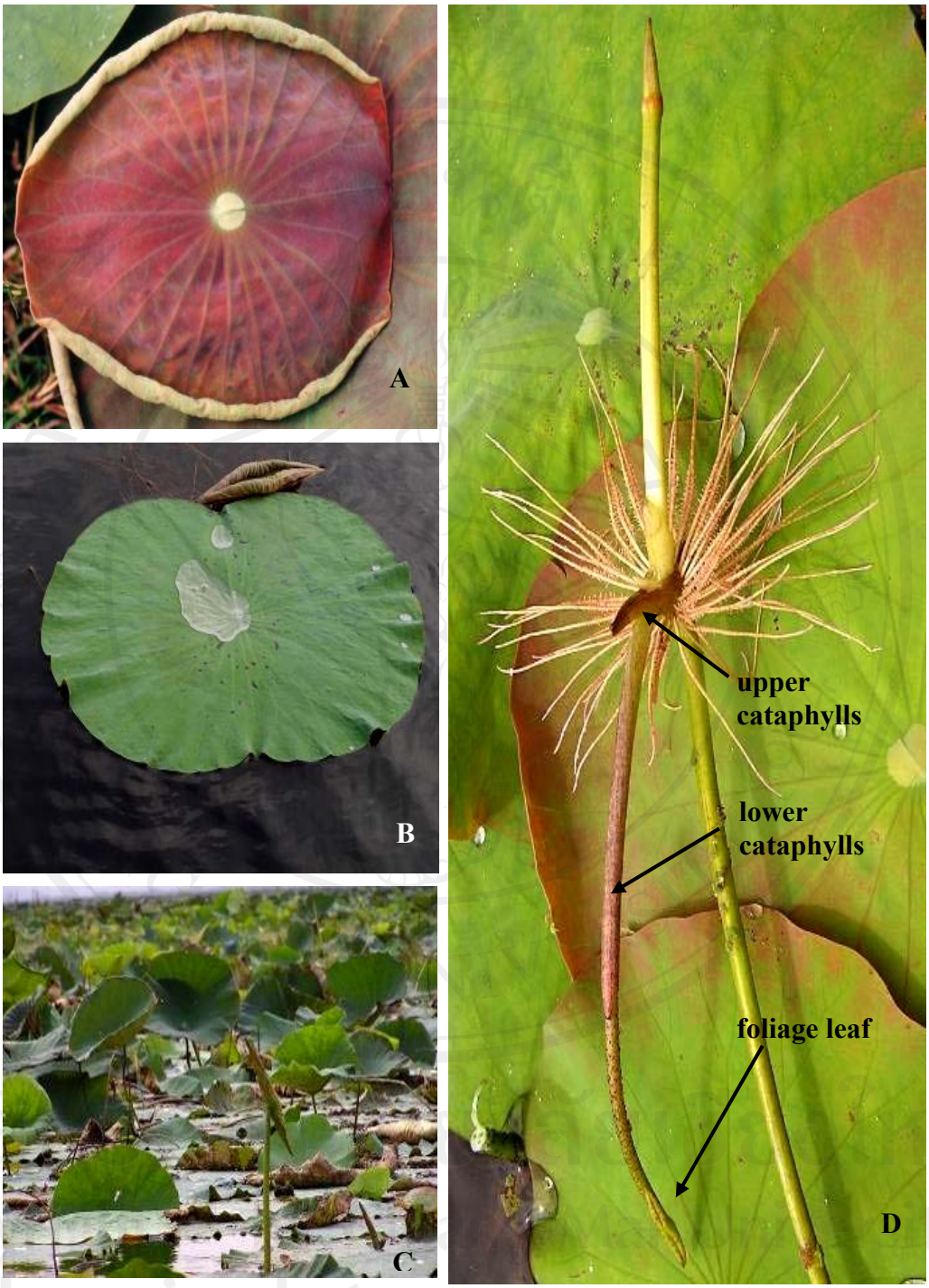

Figure 13. Leaves of *Nelumbo nucifera* Gaertn.

A. young leaf; B. floating leaf; C. foliage leaf; D. three set of phyllomes, upper cataphylls, lower cataphylls and foliage leaf.

The petiole is axillary, with a distally free stipule, which is ochrea-like but not anatomically closed, initially forming an open sheath around the terminal bud and within the lower cataphyll. The petiole of the standing leaves is harder than the floating one. It is cylindrical and has many short prickles on its surface where the latex is found inside.

The young leaf blade is laterally in-rolled from both sides and stands obliquely to the petiole. The expanded leaves are as much as 30–55 cm in diam. and usually exhibit 25 radially prominent veins.

The mature leaves are either erect or floating with the leaf blade perpendicular to the petiole. The standing leaves grow and the leaves becomes concave like a dish. The leaf-angle (the angle between the leaf blade and the petiole) is 100–135˚ degree.

Leaf anatomical features of *Nelumbo*.

Stomata are anomocytic and 15–19 µm wide and 19–31µm long, with about 400–800 stomata in a square millimeter. Guard cells are kidney shaped. The upper epidermis consists of small rectangular cells, arranged in only one layer, and with unicellular papillae (Figure 14). Palisade parenchyma are generally rectangular and found in rows, while spongy parenchyma is more unevenly shaped with air spaces in between the cells. Usually palisade mesophyll is found on the upper surface, while spongy mesophyll is found on the lower surface

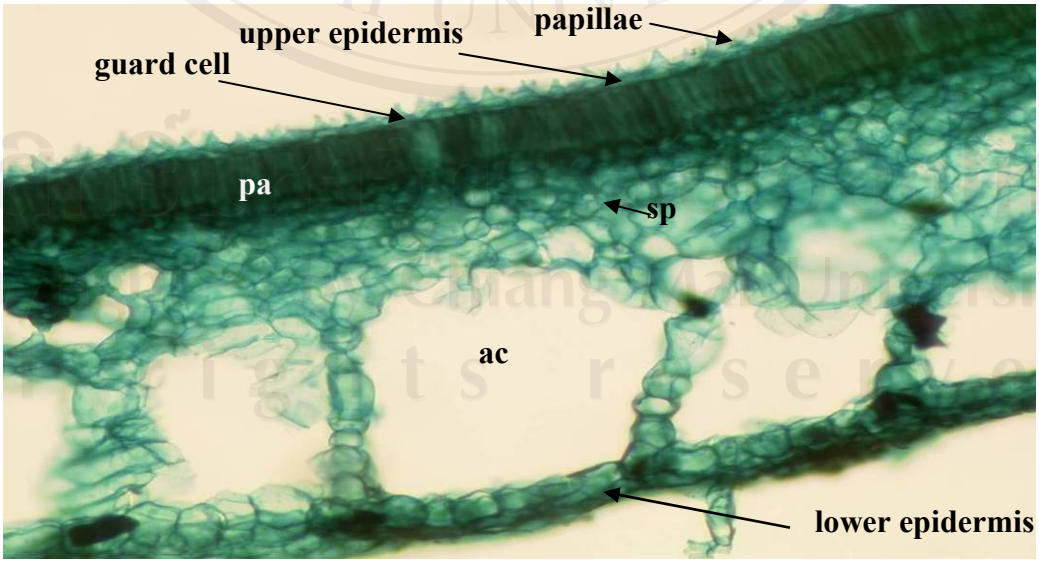

Figure 14. Transverse section of the leaf of *Nelumbo nucifera* Gaertn. (x 50). ac=air canal; pa= palisade parenchyma; sp=spongy parenchyma.

Petiole anatomical features of *Nelumbo*

The upper epidermis consists of rather small ractangular cells, arranged in only one layer, and with unicellular hairs. The cells under the epidermis at the spine attachment are parenchyma with thick walls and they accumulate the latex. The cortex consists of 3–4 layers of sclerenchyma cells, and usually the outermost layer is accumulating latex. The next layer is parenchyma, which shape is continuously large to the atactostele cell. The vascular bundles are collateral and scattered. There are four large air canals arranged in a circle of the central air canal of petiole, four medium size air canals are scattered and numerous small air canal are throughout the area. The large vascular bundles located between air canals and the small vascular bundles are between cortex and the septum of air canal. The vascular bundles consist of much xylem and phloem, but there are only 1–2 vessels in the phloem, whereas most phloem is parenchyma, sieve tube and companion cells (Figure 15).

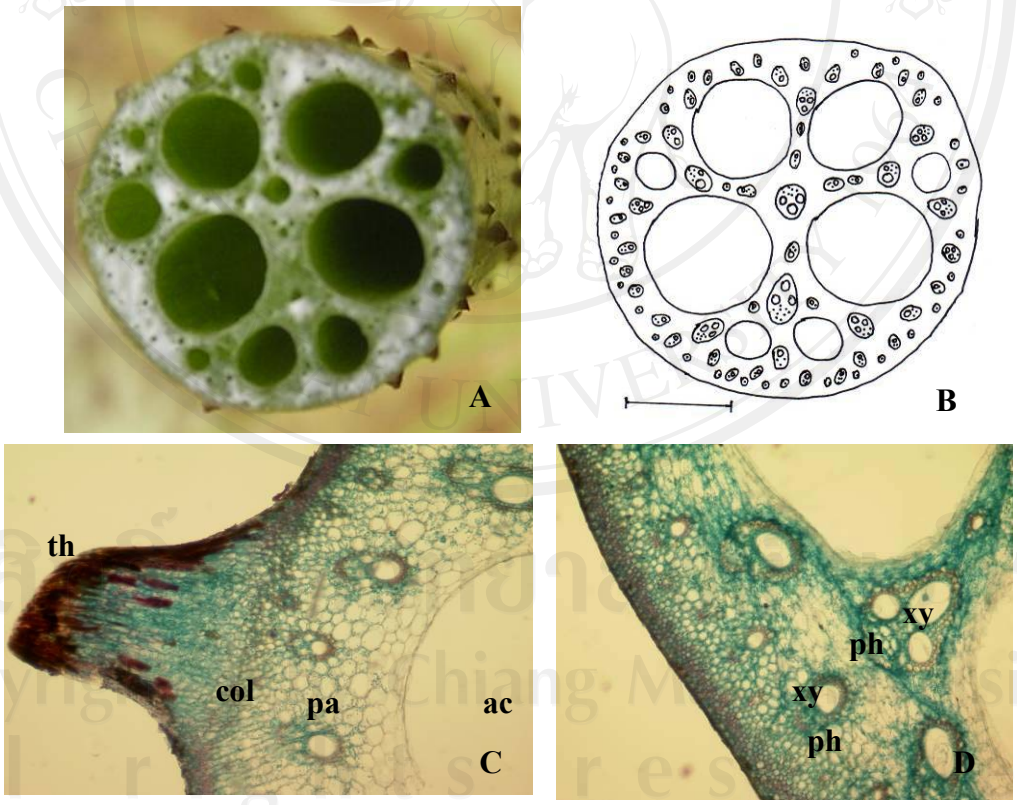

Figure 15. Transverse section of petiole of *Nelumbo nucifera* Gaertn.
A. petiole of *N. nucifera;* B. diagram of the arrangement of air canals in petiole of Thai *N. nucifera*, scale bar = 3 mm; C. D. petiole anatomical features of *N. nucifera* (x 50). ac=air canal; col=collenchyma; ep=epidermis; pa=parenchyma; ph=pholem; th=thorn; xy=xylem

5. Flowers

The flowers are solitary, axillary, bisexual and actinomorphic, elevated above the water on long terete peduncles, entomophilous (often cantharophilous), hypogynous; the receptacle is enlarged and spongy, with numerous sunken cavities containing individual carpels.

Perianth

The perianth is approximately 3-seriate, with an outermost whorl of 4–6 bracts which look like sepals. The bracts fall before the flower blooms. The next whorl is the ca 12–30 tepals that are distinct, spirally arranged; the 2–5 outermost ones are greenish sepaloid tepals, the next four are often organized as two decussate pairs, greenish, caduceus and the remaining 10–30 tepals are petaloid and not very clearly differentiated from the sepals, free, spirally arranged. The 5–8 outer petals are transitional and smaller than the more numerous inner true petals (Figure 16).

Figure 16. The perianth of *Nelumbo nucifera* Gaertn.

Androecium

The stamens of *Nelumbo nucifera* are numerous (ca 100–400), spirally arranged, apostemonous; with slender, elongate filament. Anthers of the outer stamens are extrorse. Those of the inner ones are latrorse or introrse, opening longitudinally. The tapetum is secretory. Microsporogenesis is simultaneous. A narrowly laminar connective that is conspicuously prolonged beyond the anther into a slender incurved appendage. The stamens of hybrided and mutated species of *Nelumbo nucifera* are often turn in to staminode and petaloid staminode (Figure 17).

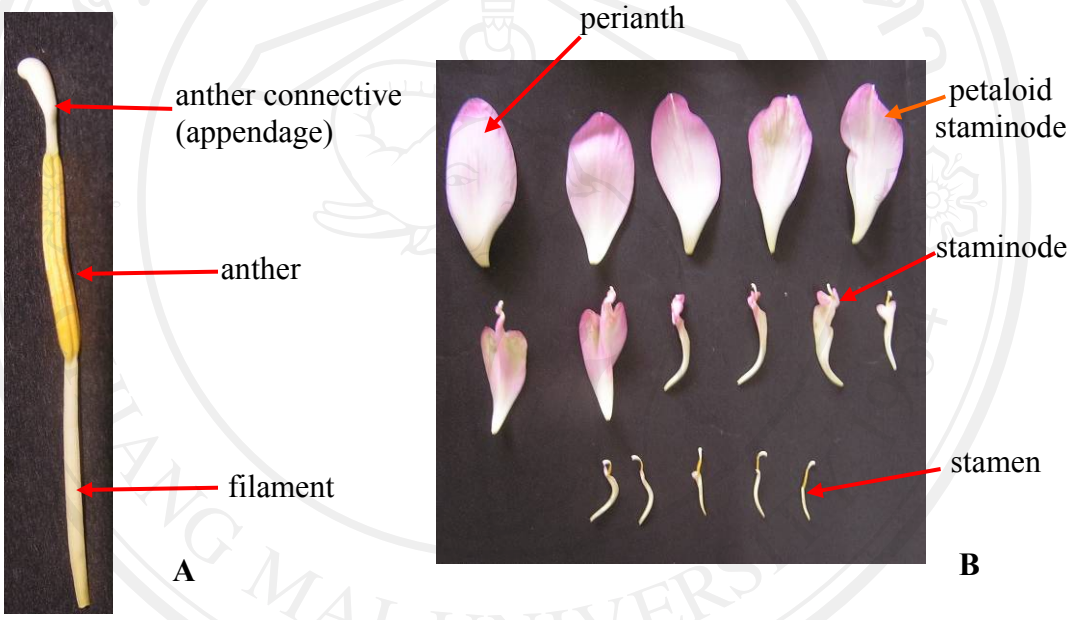

Figure 17. The androecium of *Nelumbo nucifera* Gaertn.
A. showing anthers and filaments; B. showing staminode and petaloid staminode.

Gynoecium

The gynoecium is apocarpous, with 8–40 one-loculed superior carpels arranged in 2–4 more or less distinct cycles. The carpels are individually sunken in the enlarged spongy receptacle but free. The number of carpels varies according to the forms or growing conditions. The style and stigma are solitary and terminal. Placentation is apical. The stigma is sessile, papillate, with a small depression in the center that leads into an ovary canal occluded with interlocking papillae and serving as passage for the pollen tube. Ovules are anatropous and bitegmic, one per ovary. Ovules are solitary or rarely two, and dorsally pendulous (Figure 18).

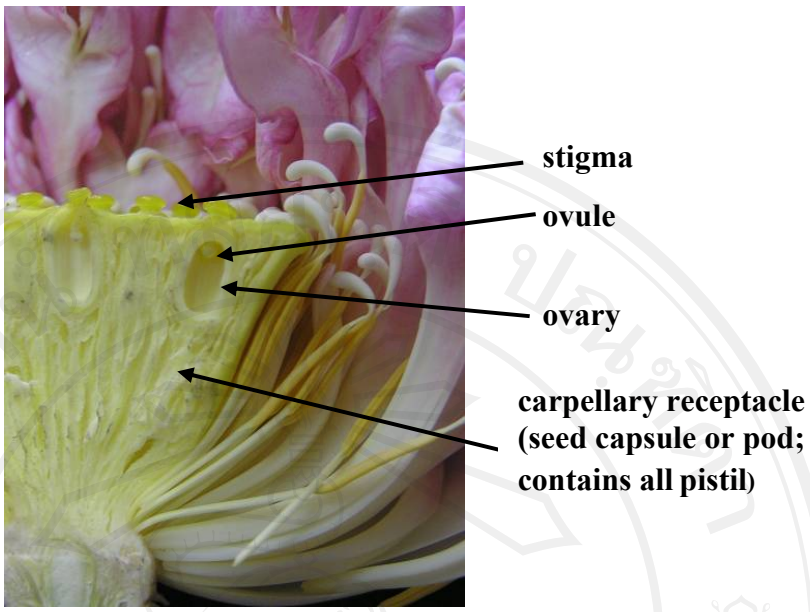

Figure 18. Gynoecium showing stigma, ovary, and ovule of *Nelumbo nucifera* Gaertn.

Peduncle anatomical features of *Nelumbo*

The epidermis consists of rather small rectagular and square cells, arranged in only one layer. The cortex consists of 2–3 sclerenchyma cell layers and usually the upper layer accumulate water or latex, the next layer is parenchyma, which shape is large and continuous to the atactostele cell. There are small air canals in the central part and 6–8 large air canals, of which the middle canals are scattered between the large canals and small canals which are found throughout the area. There are druse crystals in the inner and outer parenchyma cells which are arranged around athe air canals. The vascular bundle is collateral, in regular arrangement. The large vascular bundles are located in the central section of the peduncle. Six to eight vascular bundles are arranged in a circle. Each collateral bundle has some laticifers between the xylem and phloem. A bundle is located in the septum of the large air canal (Figure 19, 20).

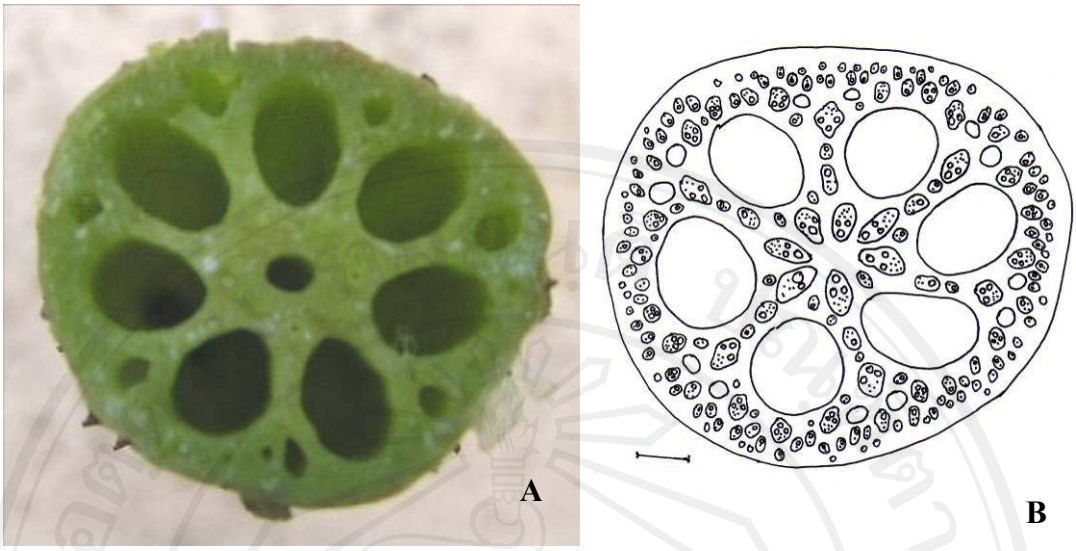

Figure 19. Transverse sectoin of peduncle of *Nelumbo nucifera* Gaertn.
A. petiole; B. diagram of the arrangement of air canals in peduncle, scale bar = 2 mm.

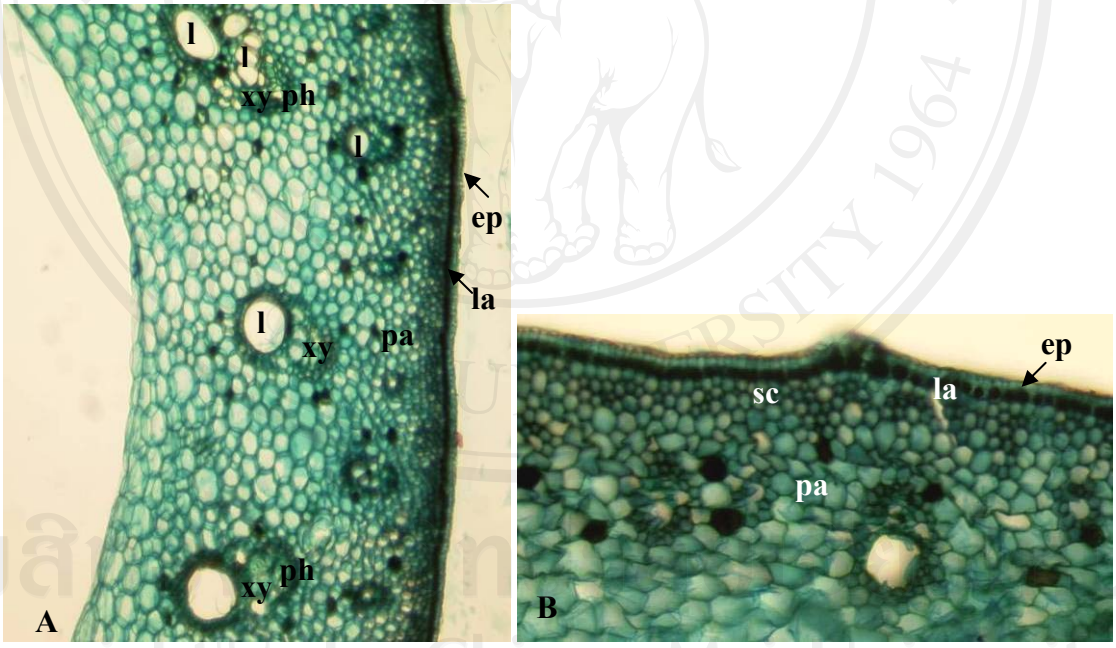

Figure 20. Transverse section of the peduncle of *Nelumbo nucifera* Gaertn.
A. B. vascular bundle in the peduncle of *Nelumbo nucifera* Gaertn. (x 100). ep=epidermis; la=latex; sc=scerenchyma; pa=parenchyma; l=laticifer; ph=phloem; xy=xylem.

6. Fruit

The fruit is an aggregate of nuts with leather-like pericarp. It contains the seeds within little circular chambers on the flat surface on the top of the fruit, each sunken in an accrescent receptacle, each seed with a small respiratory pore (remnant of the ovarian canal) at the top (Figure 21).

Figure 21. The fruit of *Nelumbo nucifera* Gaertn.

7. Seed

The seeds are large, ovoid, exarillate, with a thin seed coat consisting of pressed remnants of both integuments. The embryo is very large, with vestigial endosperm represented by a thin film in the chalazal part around the tips of cotyledons and plumule, and without perisperm. The cotyledons are large, fleshy, connate by their margins for most of their length, forming a thick cup-shaped structure surrounding the well-developed green plumule of 3–4 dark green young leaves. The radicle is abortive (Figure 22).

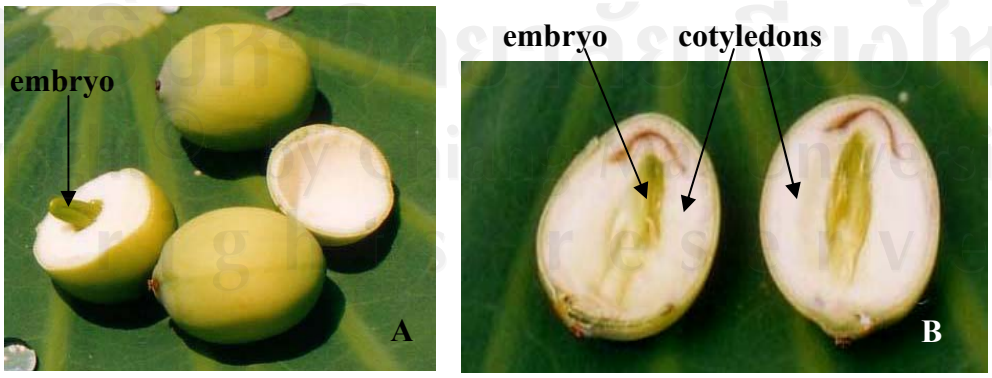

Figure 22. The seed of *Nelumbo nucifera* Gaertn.

A. showing the embryo; **B**. transverse section of seed, showing the cotyledons and embryo.

NYMPHAEACEAE

1. Habit

Acaulescent perennial or rarely annual aquatic herbs with vertical rhizomes with generally submerged or floating leaves.

2. Rhizome

Rhizomes of Thai Nymphaeaceae are short, thick, erect caudices, resting tubers of various size and shapes, more or less acute above with the apex covered by hairs merged with dried and wrinkled petioles base. The petiole and peduncle scars are prominent on the surface of rhizomes (Figure 23).

Figure 23. Rhizome and tuber of Nymphaeaceae.
A. rhizome and tuber of *Nymphaea nouchali* Burm. f.; B, C. tuber of *Nymphaea rubra* Roxb. ex Salisb.

3. Leaves

The leaves of Nymphaeaceae are simple and flat, round, ovate, heart-shaped or linear (*Barclaya longifolia*) with the margins notched and entire, undulate or crenate (*Barclaya* spp. and *Nymphaea* subgenus *Brachyceras*), dentate and with acute teeth (*Nymphaea* subgenus *Lotos*), up to 40 cm in diam. and cleft almost to the centre where the petiole is attached. The leaves are usually seen floating on the surface of the water but may also be submerged. The leaves are attached by long stalks that arise directly from the tuberous rhizome which is rooted in the muddy pond bottom. The leaf stalk is attached near the center of the lamina to form a peltate leaf or at the base of a deep notch in the lamina. The leaves are relatively short lived and they are replaced regularly throughout the growing season. They start out being soft and shiny green at the centre of the plant, and then develop light brown or purple splashes that eventually cover the leaf, leaving only the veins green. They then start to die, turning yellow then brown and eventually disappear under the water. One plant can spread over an area of several square meters (Figure 24).

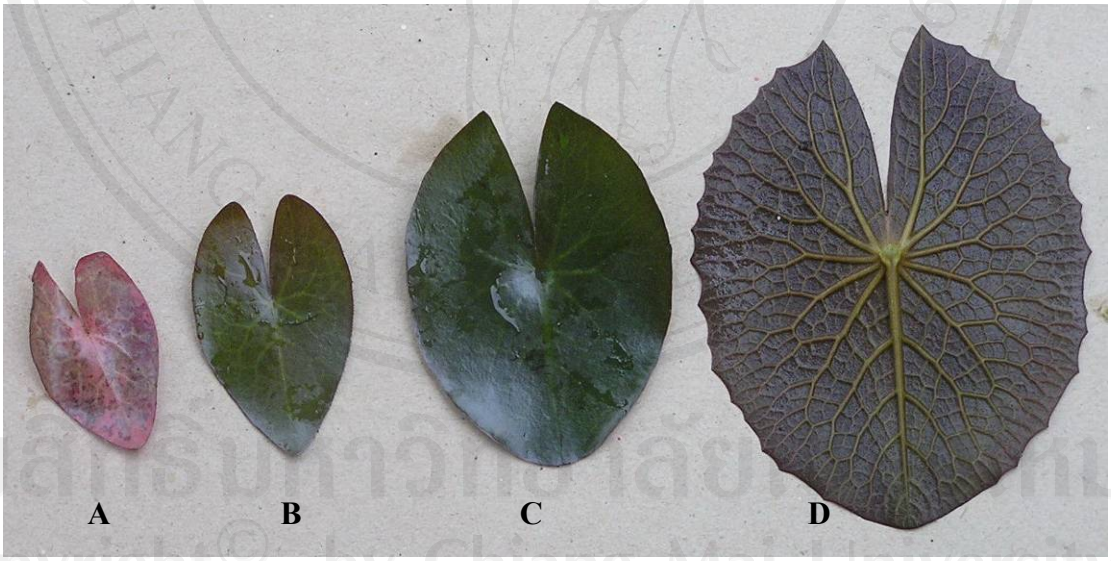

Figure 24. Leaf of *Nymphaea rubra* Roxb. ex Salisb.
A. lamina of first submerged leaf; B. lamina; C, D. second and third floating leaves.

Leaf anatomical features of *Nymphaea*

The upper epidermis characterized by cuticle on its outer surface and consists of square or polygonal cell. Stomata are present only on the upper surfaces of the floating leaves, guard cell stand on a level with the surrounding epidermis. The palisade layer is very deep and composed of parallel strings of cylindrical cells, between these are long, narrow air canals, connecting with the spongy mesophyll below. In the spongy layer these are usually of the astrosclereid or trichosclereid or polyramous sclereids in *Barclaya longifolia*. Vascular bundles embedded in the plate of parenchyma and along its sides are several air canals. Each vascular bundle is surrounded by a sheath of parenchyma cells much smaller than the neighboring tissue. Xylem well developed, spiral tracheae and companion cell is present, it is less in amount than the phloem. The lower epidermis is a continuous layer, thick, quite smooth on the outer surface, and consisting for the most part of polygonal cell. In these is located the pigment which colors the under side of the leaf. In *Nymphaea rubra, N. pubescens* permanent hair stand on many of these basal cells, the hair is unicellular.

Petiole and peduncle anatomical features of *Nymphaea*

The epidermis is composed of four sided cells arranged in regular longitudinal rows. Under the epidermis layer is collenchyma in which the cells are small or medium sized. The cortex consists of stellate parenchyma with large intercellular spaces. There are astrosclereid cells inserted throughout the area of parenchyma. The stele is an atactostele. The vascular bundles are collateral. Their arrangement differs according to that of the air canals and the size of petiole. There are two main air canals, a large double bundle at each end of the septum between the canals, and the two smaller bundles inserted on each side of canals equally distant from each other. The arrangement of air canals is different in each group as show in the diagram (Figure 25 - 28).

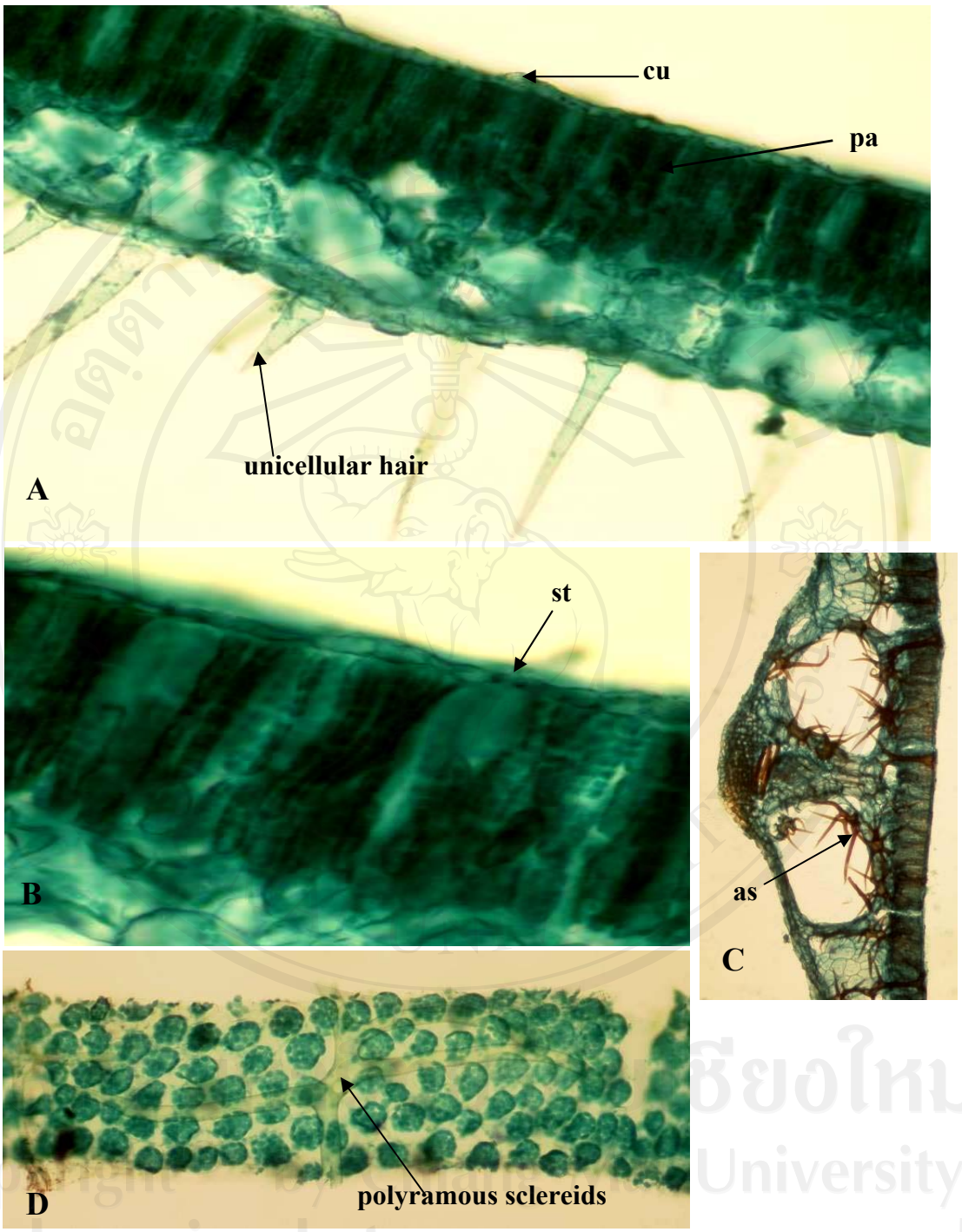

Figure 25. Leaf anatomical feature of Nymphaeaceae.

A. unicellular hair in *Nymphaea rubra* Roxb. ex Salisb. leaf (x 100); B. stomata in the epidermis of *N. pubescens* Willd. leaf (x 100); C. astrosclereid cell in *N. nouchali* Burm.f. leaf (x 50); D. *Barclaya longifolia* Wall. lamina showing polyramous sclereids (x 100). cu= cuticle; pa= palenchymna; st= stomata; as= astrosclereid.

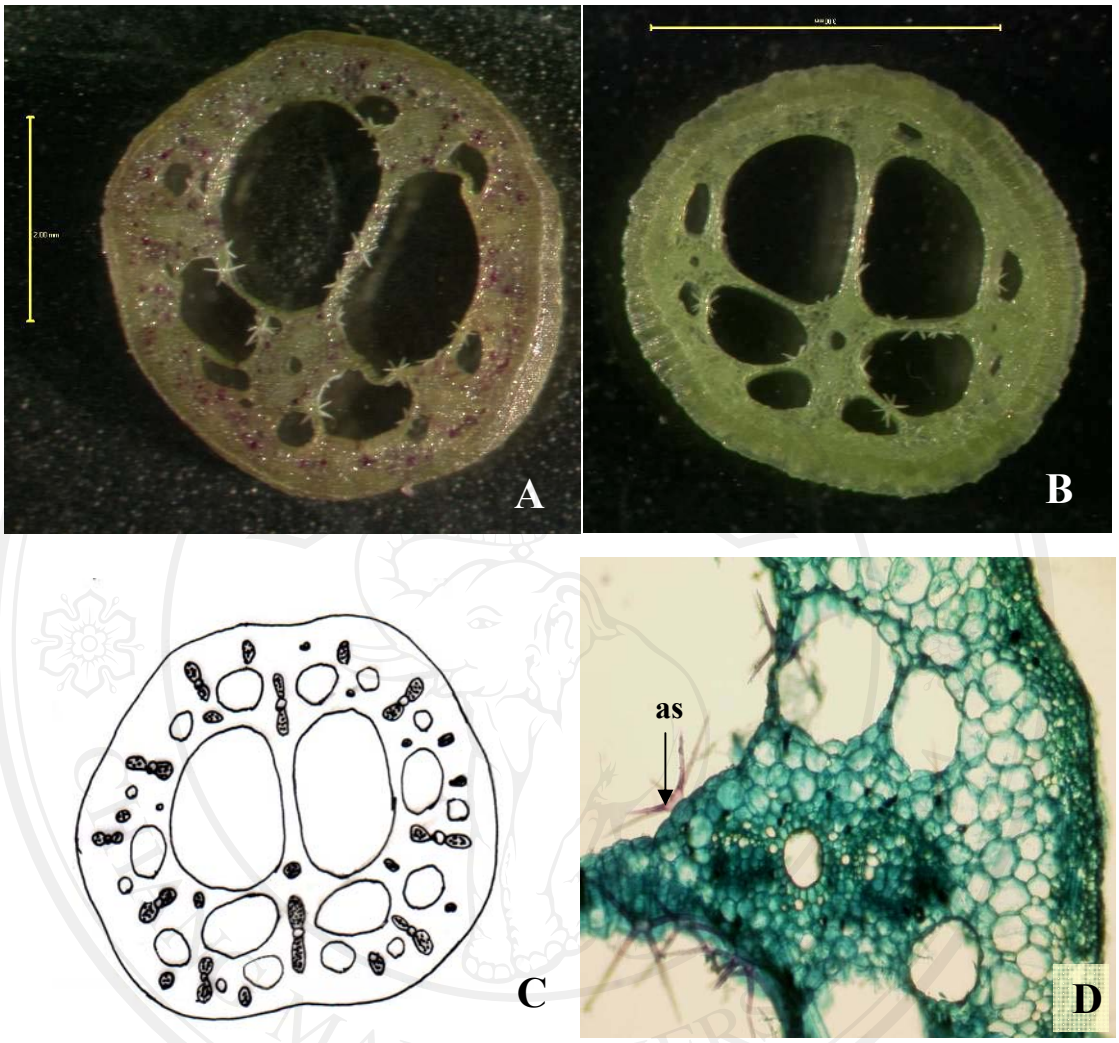

Figure 26. Transversee section of petiole of subgenus *Brachyceras*.
A. petiole of *Nymphaea cyanea* Roxb.*;* B. petiole of *N. nouchali* Burm.f. *;* C. diagram of the arrangement of air canals in petiole of Thai *Nymphaea* in subgen. *Brachyceras;* D. petiole anatomical feature of *N. nouchali* Burm.f. showing astrosclereid cells (x 50), as=astrosclereid cells. Scale bar for A = 2mm; for B = 3 mm.

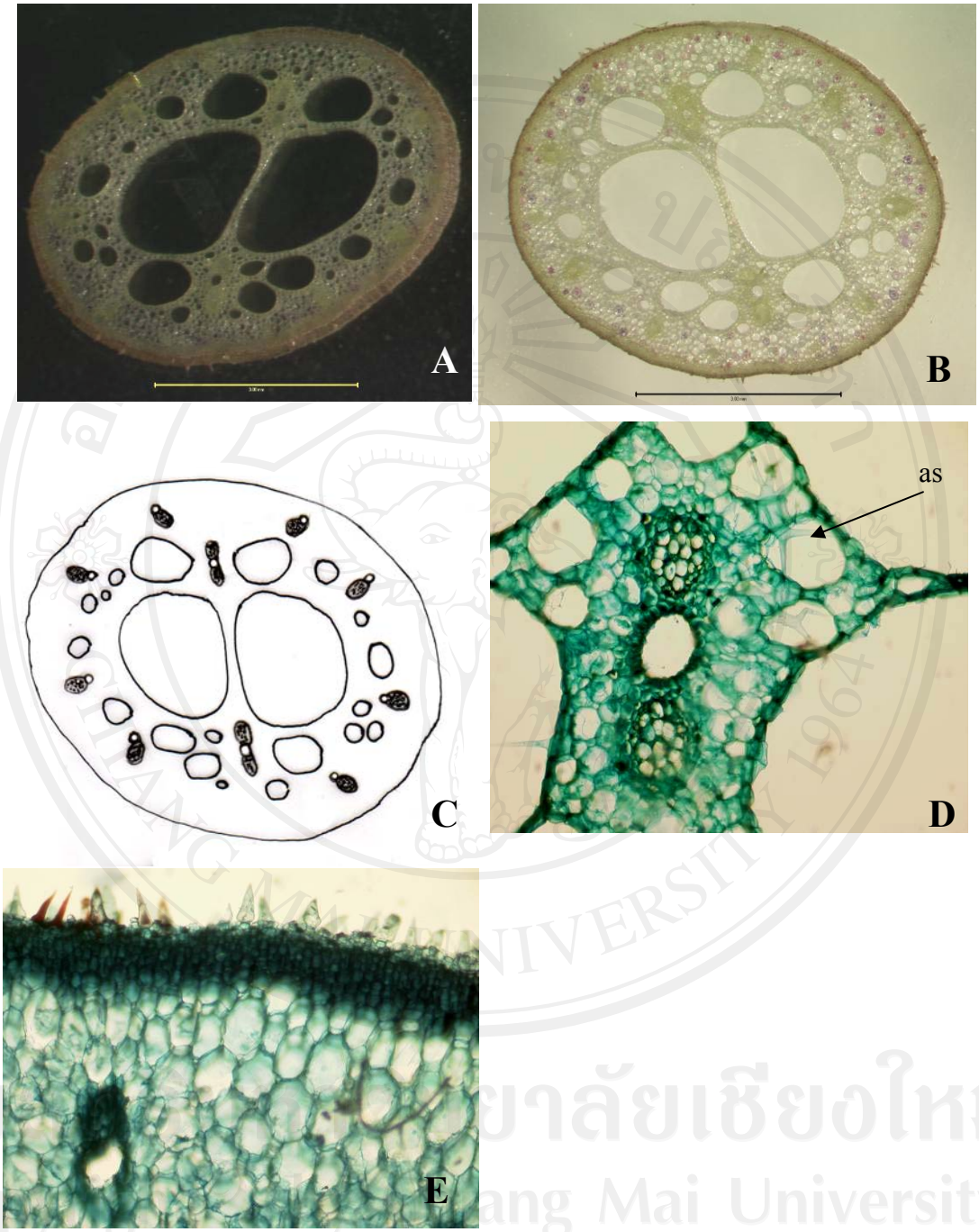

Figure 27. Transverse section of petiole of subgenus *Lotos*.
A. petiole of *Nymphaea pubescens* Willd.*;* B. petiole of *N. rubra* Roxb. ex Salisb.*;* C. diagram of the arrangement of air canals in petiole of Thai *Nymphaea* in subgen. *Lotos;* D. anatomy of petiole of *N. pubescens* Willd. showing vascular bundle with one air canal and astrosclereid cells (x 50); E. papillae on the surface of peduncle of *N. pubescens* Willd.; as=astrosclereid cells. Scale bar for A and B = 3 mm.

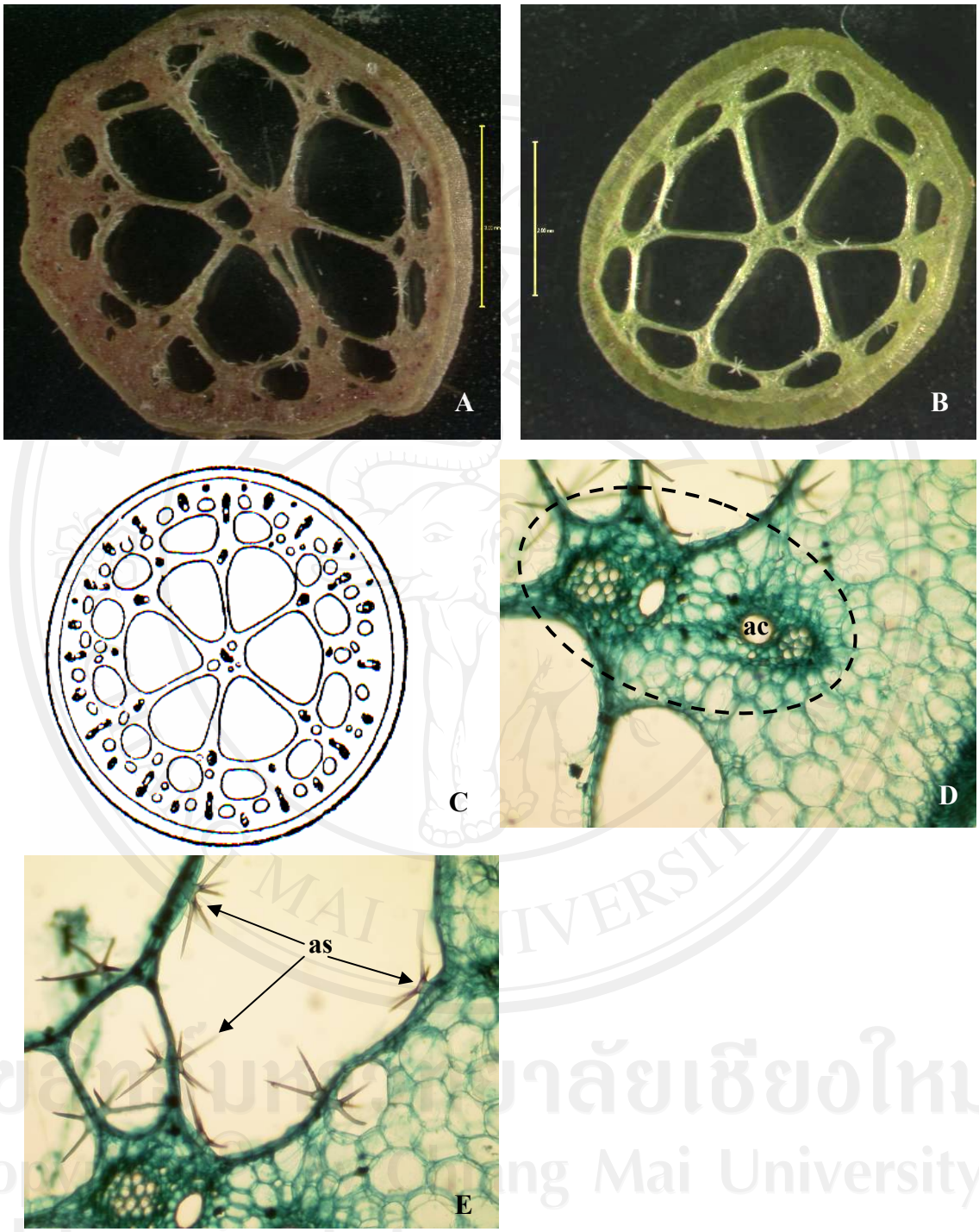

Figure 28. Transverse section of peduncle of subgenus *Brachyceras*.
A. *Nymphaea cyanea* Roxb.*;* B. *N. nouchali* Burm.f.*;* C.diagram of the arrangement of air canals in peduncle of Thai *Nymphaea* in subgen. *Brachyceras;* D, E. anatomy of peduncle of *N. nouchali* Burm.f. (x 100); D. double bundle with two canals of *N. nouchali* Burm.f.*;* E. astrosclereid cells. ac=air canal; as=astrosclereid cells.
Scale bar for A = 3 mm; for B = 2mm.

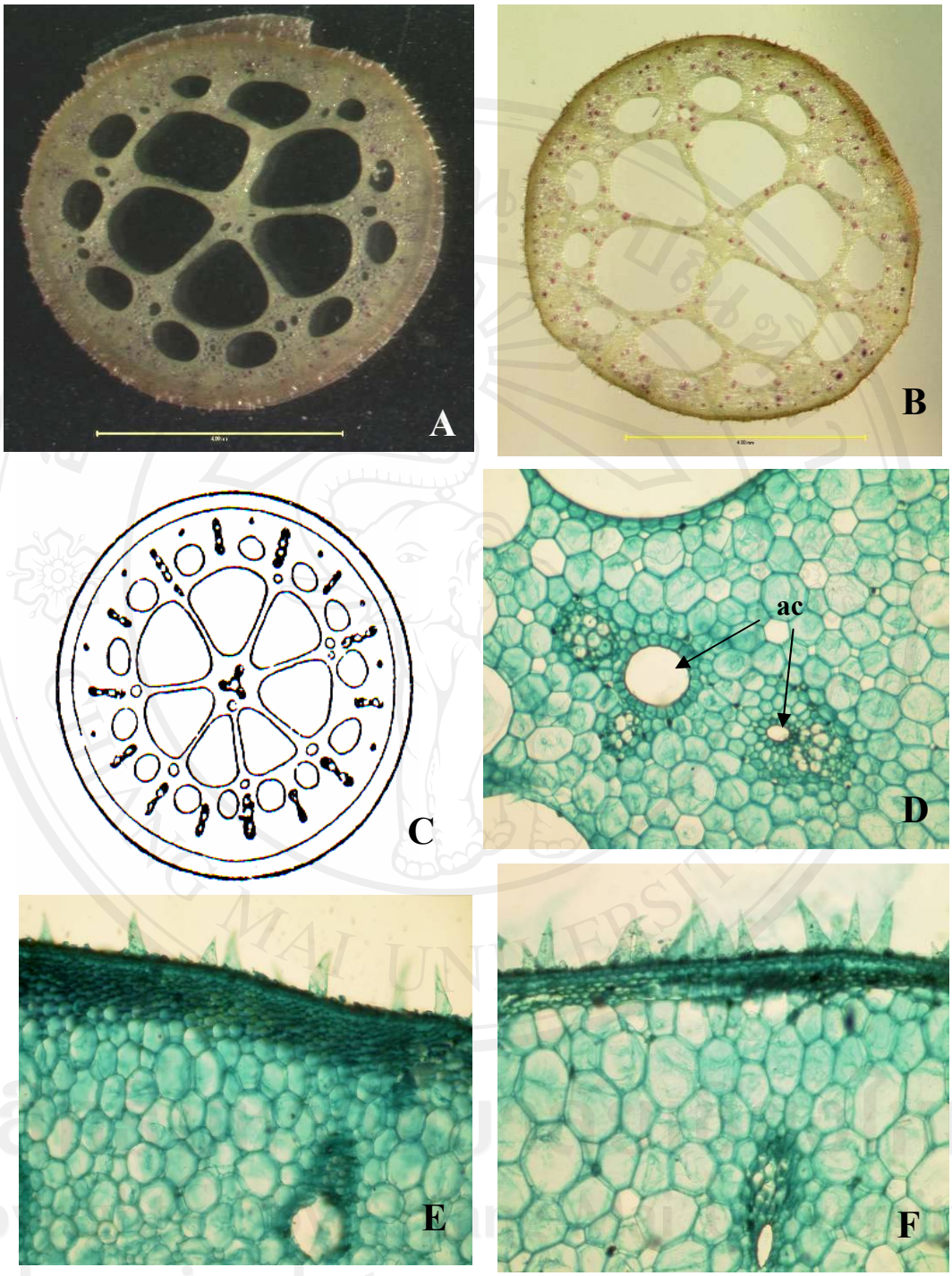

Figure 29. Transverse section of peduncle of subgenus *Lotos*. A. *Nymphaea pubescens* Willd.; B. *N. rubra* Roxb. ex Salisb.; C. diagram of the arreangement of air canals in peduncle of Thai *Nymphaea* in subgen. *Lotos.;* D, E, F. anatomy of peduncle (x 100); D. double bundle with two canals of *N. pubescens* Willd.*;* E. F. Papillae on the surface of peduncle; E. *N. rubra* Roxb. ex Salisb.; F. *N. pubescens* Willd. ac = air canal. Scale bar for A and B = 4mm.

4. Flowers

The flowers are usually raised above the water on long peduncles arising from the rhizome, and may be as large as 30 centimeters across, solitary, axillary, generally emergent actinomorphic, entomophilous, mostly spirocylic, perfect, regular, floating (in *Barclaya*) or emergent. They are bisexual with numerous petals and stamens, actionomorphic, and hypogynous or epigynous,

Perianth

The perianth is unusually conspicuous and differentiated into a calyx and a corolla and basically 3-merous with spirally arranged parts. The calyx usually consists of 4–6, aposepalous sepals. The corolla consists of four (*Barclaya* sp.) to 70, distinct to connate (*Barclaya* sp.), apopetalous petals, the inner of which grade into laminar stamens (Figure 30).

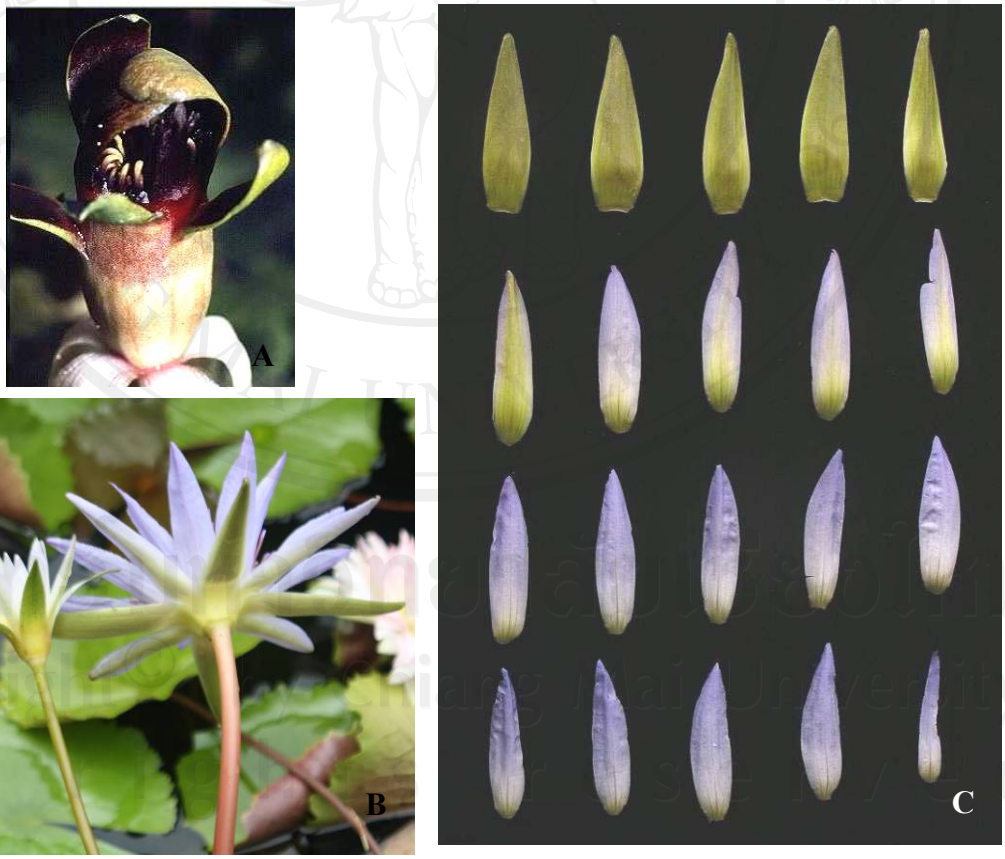

Figure 30. Perianth of Nymphaeaceae.

A. flower of *Barclaya longifolia* Wall. showing corolla.

B. flower of *Nymphaea cyanea* Roxb. and *N. nouchali* Burm.f. showing perianth.

C. perianth of *N. cyanea* Roxb.

Androecium

Stamens are numerous, spirally arranged, mostly laminar and 3-veined, with elongate microsporangia more or less often differentiated into filament and anther, sunken into the adaxial side of the blade, less commonly transitional toward the familiar staminal type with well developed filament and anthers that are free and distinct, sometimes some of the inner or outer ones staminodial. The filaments are free or adnate to the petaloid staminodes, slender and well differentiated from anthers, laminar to the outside, grading morphologically into petals, to terete toward the flower center. The anthers are tetrasporangiate, dehiscing longitudinally, and with a connective often extending beyond the anther (Figure 31).

Figure 31. Androecium of *Nymphaea rubra* Roxb.ex Salisb.

Gynoecium

The gynoecium is apocarpous or syncarpous with a superior to partly inferior ovary, and 3–35 carpels; placentation is lamellate or parietal; ovules one to numerous, anatropous or (*Barclaya* spp.) orthotropous, bitegmic and numerous per carpel; the carpels are distinct or connate, partially fused to syncarpous, more or less firmly united into a compound, superior to inferior ovary that is apically constricted beneath and expanded into a dish bearing radiate stigmatic lines, or the stigmas form a broad, radially grooved and marginally lobed disk that surrounds a knob that appears to be a prolongation of the floral axis (the lobes are numerous in *Nymphaea*). Endosperm-development cellular or nuclear or helobial (Figure 32).

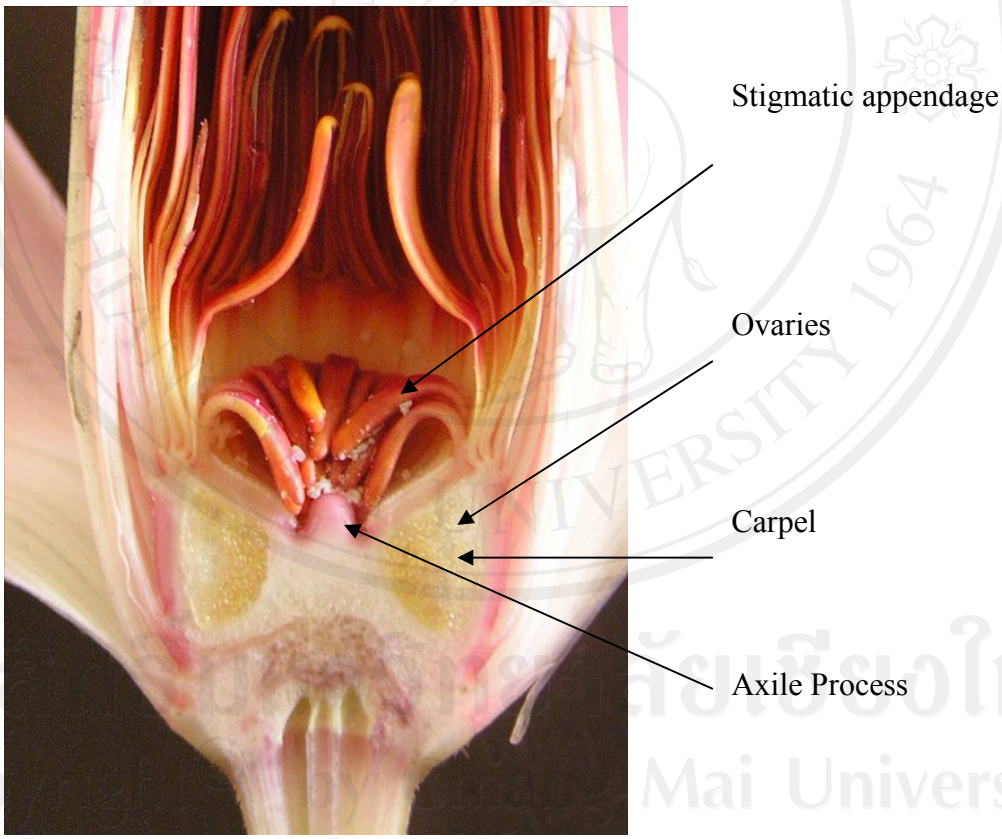

Figure 32. Gynoecium of *Nymphaea rubra* Roxb. ex Salisb.

5. Fruit

The fruit is a fleshy or spongy berry and splits irregularly after ripening, usually developing underwater by the peduncle becoming laxed or coiled, rupturing along the dorsal carpellary wall due to the enlargement of numerous seeds and swelling of mucilage within the locules. The segments float, carrying the seeds away from the parent plant (Figure 33).

Figure 33. Fruit of *Nymphaea*.
A. *Nymphaea pubescens* Willd. fruit; B. *Barclaya longifolia* Wall. fruits.

6. Seed

The seeds are small, operculate (opening by a cap), mostly arillate except in *Barclaya,* and with rather scanty endosperm and copious perisperm with clustered starch-grains. The seed coat is formed mainly by the outer integument (Figure 34). The embryo is small, with thick, hemispherical, fleshy cotyledons. There are two cotyledons which are wholly distinct, or developing as separately vasculated lobes from an annular common primoridum.

Figure 34. Seeds of Nymphaeaceae.
A. *Nymphaea pubescens* Willd., scale bar = 1 mm.
B. *Nymphaea nouchali* Burm. f., scale bar = 2 mm.

GENERRAL ECOLOGY AND DISTRIBUTION

Habitat

Nelumbonaceae and Nymphaeaceae occur in wetlands in tropical and temperate climates of both hemispheres. In Thailand, they are found in open waters of large swamps, lakes, ponds, shallow ditches and also in the extensive marshes that can be found in all regions but they are most common in the central and northeastern regions at low to high altitudes. *Barclaya* in Nymphaeaceae is found in slow flowing streams in tropical rain forests. Temperature and humidity appear to be important factors and they grow best at 25–40^{o}C and in water 20–100 centimeters deep but do best in water 20–50 centimeters deep. Initial establishment is presumably in shallow water with expansion into deeper water. They grow in still water but can be revolved.

Reproductive Ecology

The blooming season for *Nelumbo nucifera* is usually from late May to the middle of September. It produces flowers within 20 days after emerging from the water. For their blooming, temperatures above 18^{o}C are required. The petals have enzymes that perceive the light and causes the action of opening and closing. On the first day the flower begins to open about 4–5 a.m. and begin closing at about 8 a.m. The second day it begins to loosen about 1 a.m. and come into full bloom at 7–9 a.m. with the shape of a bowl, the anthers open and scatter their scent and it closes at noon. The third day it begins to loosen at 1 a.m. through 9 a.m. and begins to close at noon and close in the half open state. On the fourth day it falls in the afternoon.

Nymphaeaceae flowers are bisexual and protogynous, although homogamy has been reported in several species (Endress, 2001). The species of *Nymphaea* may be either day-blooming or night-blooming and the two groups have long been recognized as taxonomically separated. The pollination in the day-blooming species is commonly done by bees or flies (van der Velde *et al.,* 1978; Schneider, 1982; Capperino and Schneider 1985), (Figure 35). The flower opens for three consecutive days; the first day a pool of stigmatic fluid fills the centre of the flower, covering the female parts but pollen is not released. Should an insect visit the flower, the design of the petals causes it to fall into the fluid. If the insect is covered in pollen from a visit to an older staminate flower, the pollen is washed off and floats to the stigma where it

causes cross-pollination. By mid to late morning, the flower closes and remains closed until dawn the following day when no fluid is produced, but the stamens mature and shed their pollen instead. Visiting insect come to feast on the pollen, get covered with it and carry it away to pollinate flowers that are in their first day of anthesis.

In the night-flowering species of *Nymphaea*, the flowers are also protogynous but anthesis lasts a bit longer, *i.e.,* for 4–5 days. Flowers open at sunset and close in the morning hours with a high variability in timing associated with heating up of the floral parts. During the night flowers are visited by beetles that feed on flower parts and use the flowers as a place to copulate. These beetles are less effective pollinators than several bee species that visit the flowers in the early morning hours. The night-blooming *Nymphaea* thus appear to be adapted to pollination by both nocturnal beetles and diurnal bees (Hirthe and Porembski, 2003), (Figure 35).

A few days after the flower has been pollinated, the peduncle tightens in a spiraling spring that pulls the flower head underwater where the fruit develops into a spongy berry with many seeds that are enclosed in arils. When ripe, seeds are released from the fruit and float because they contain air pockets. They are dispersed by water currents or by water birds that eat them. As they become water logged, they sink into the mud where they may germinate. The plant also spreads by sprouting from the creeping rhizomes.

The flower of *Barclaya longifolia* appears to be cleistogamous and self-pollinating within the unopened flower.

In Thailand most Nymphaeaceae bloom between late June and the middle of September.

Figure 35. Stingless bee foraging for pollen in the flower of *N. rubra* Roxb. ex Salisb. and *N. cyanea* Roxb.

Distribution

Based on the present study (see Taxonomic Part), one species of Nelumbonaceae and two genera and six species of Nymphaeaceae occur in Thailand. Their distribution is shown in Figure 36. For the purpose of *Flora of Thailand* the country is divided into seven floristic regions. The distribution within these regions is as follows (Table 2): One species of Nelumbonaceae is distributed in all regions. Four species of *Nymphaea* occur in the North, Northeast, and South-east Regions. Three species of *Nymphaea* occur in East, Southwest and Peninsular Regions. One species of *Barclaya* occur in Northeast, South-east Central and Peninsula Regions. Both species of *Barclaya* occur in the Peninsular Region.

Nelumbo nucifera, Nymphaea nouchali, Nymphaea pubescens and *Nymphaea rubra* are distributed in all regions. *Nymphaea cyanea* is distributed in the North, North-east, Southeast and Central Regions of Thailand. *Barclaya longifolia* distributed in the Northeast, South-east, Central and Peninsula. *Barclaya motlyi* occurs only in Peninsula.

Table 2. Distribution of the species of *Nelumbo, Nymphaea* and *Barclaya* in Thailand.

Taxa	N	NE	E	SE	C	SW	PEN
Nelumbo nucifera	+	+	+	+	+	+	+
Nymphaea cyanea	+	+		+	+		
Nymphaea nouchali	+	+	+	+	+	+	+
Nymphaea pubescens	+	+	+	+	+	+	+
Nymphaea rubra	+	+	+	+	+	+	+
Barclaya longifolia		+		+	+		+
Barclaya motlyi							+

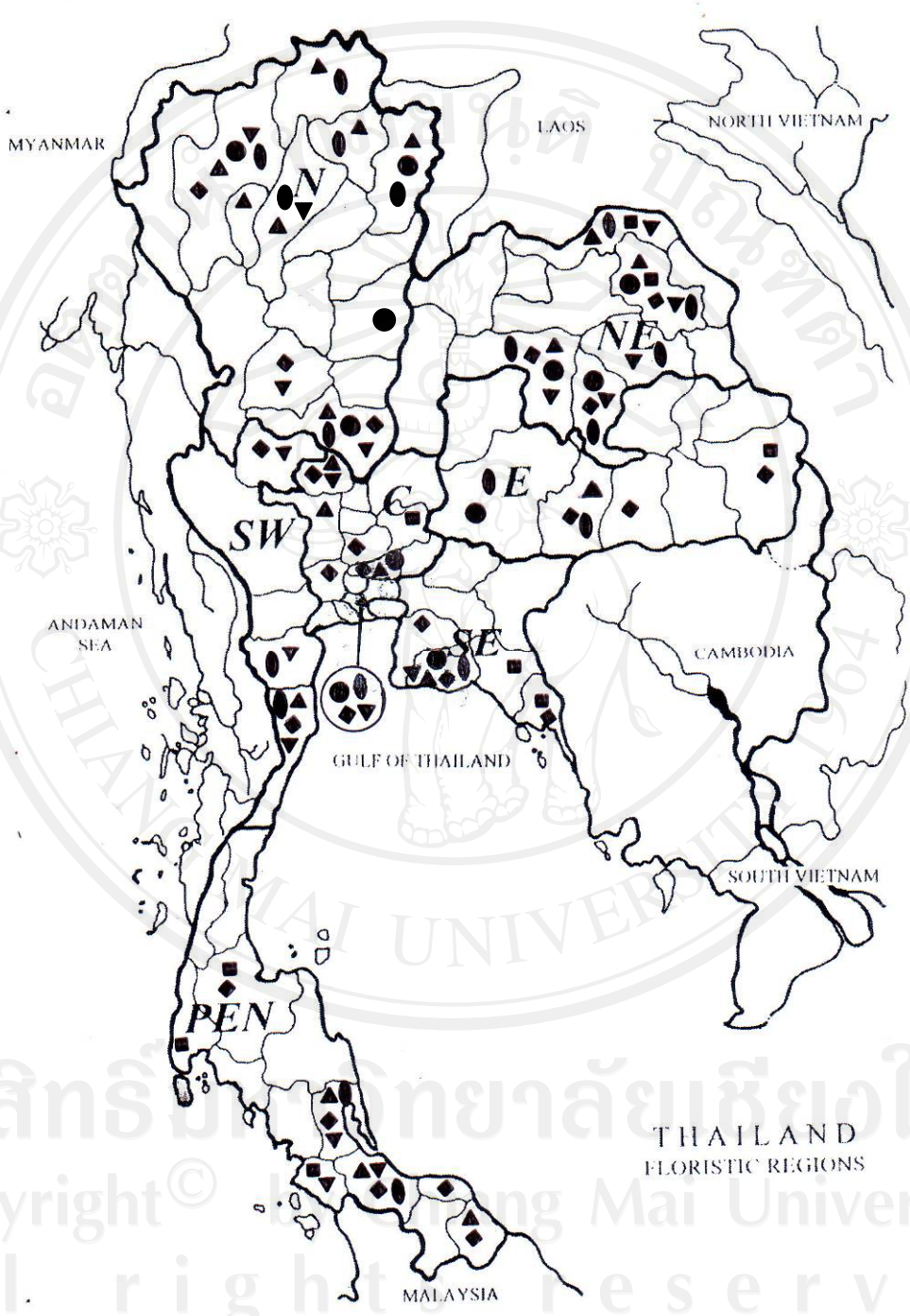

Figure 36. Distribution of *Nelumbo nucifera* Gaertn. = ▲; *Barclaya longifolia* Wall. = ■; *Nymphaea cyanea* Roxb. = ●; *Nymphaea nouchali* Burm. f. = ♦; *Nymphaea pubescens* Willd. = ▼; *Nymphaea rubra* Roxb. ex Salisb. =⬮.

TAXONOMY

1. Typification of Thai Nelumbonaceae and Nymphaeaceae

It appears that no species of Nymphaeaceae and Nelumbonaceae has been described on material collected in Thailand. Instead most of the names and synonyms applied to the Thai species of the families are based on collections from neighboring countries in SE Asia such as India, Malabar Islands, Burma, etc. and a few on even material collected in even more distant countries such as Tanzania. A feature relating to the typification of these names is that many of them were brought into cultivation as aquatic ornamentals and the plants were therefore often mentioned in less than formal horticultural publications for some time before they were formally and scientifically described. This study attempted to track down the original specimens, but realize that some future refinements may be necessary when the SE Asian water lilies have been revised in a regional perspective and all historical collections have been studied in more detail.

2. NELUMBONACEAE

Botanical characters of the genus *Nelumbo*

***Nelumbo* (Tourn.) Adans.**

Nelumbo (Tourn.) Adans., Fam. 2 (1763) 76.— *Nelumbium* Kussieu, Gen. Pl. (1789) 68. — *Cyamus* J. E. Smith, Ex. Bot. I (1806) 59, t. 31 and 32. — *Tamara* Rheede, Hort. Malab. II (1692) 59, t, 30; Roxburge ex Steudel, Nomencl., ed. 2, 4 (1841) 661. Bem-Tamara Rheed, Hort. Malab. II (1692) 61, t. 31. — *Nymphaea* L., Gen. Pl. (1754) 227, p.p. Type : *Nelumbo nucifera* Gaertner.

Erect, perennial herbs with milky sap. Root stock stout, creeping. **Leaves** of young plants floating, of older ones raised above the surface of water, alternate, orbicular, peltate, glabrous, prominently veined from the centre on the under surface. **Flowers** large, pinkish-red, white or rarely yellow. **Sepals** 4–5, inserted on the top of the pedicel, caducous. **Petals** and stamens numerous, many-seriate; anthers linear

with connectives prolonged into clubbed, white appendages. **Ovary** many, surrounded by and embedded in cavities of the turbinate, spongy torus; ovule solitary, pendulous, style very short, stigma peltate. **Fruit** ovoid, ripe carpels loose in the cavities of the enlarged torus which breaks off and floats until it decays and releases the ripe carpels; pericarp bony, smooth. **Seed** filling the carpel, testa spongy, albumen absent, cotyledons thick, fleshy.

Wild species

***Nelumbo nucifera* Gaertn.**

Nelumbo nucifera Gaertn., Fruct, 1:73, t 19., f. 2. 1788. — *Nelumbo zeylanensium* Tourn., Inst. 261. 1700. *nom. nod.* — *Nymphaea nelumbo* L., Sp. Pl. 511. 1753. — *Nelumbo indica* Poir. in Lamarck, Encycl. 4: 453. 1797, *nom. illegit.* - *Nelumbium speciosum* Willd. Sp. Pl. ed. 4, 2, 2 1258. 1799. — *Nelumbo indica* Pers. Syn. 2. 92. 1807. — *Cyamus nelumbo* (L.) Sm. Exot. Bot. 1: 59. t. 31&32. 1807. — *Nelumbium asiaticium* Rich., Ann. Mus. Natl. Hist. Nat. 17: 249. 1811. — *Nelumbium speciosum* Willd. var. β *Tamara* DC., Syst. Nat. 2: 45. 1821. — *Nelumbium speciosum* Willd. var. γ *Capsicum* (Fisch.) DC., Syst. 2. 45. 1821. — *Cyamus mysticus* Salisb., in Koen, & Sims, Ann. of Bot. 2. 75. 1805. — *Nelumbium tamara* (DC.) Sweet, Hort. Brit. 14. 1827. *nom. nud.* — *Nelumbium rheedei* C. Presl, Reliq. Haenk. 2: 83. 1835. — *Tamara alba* Roxb. ex. Steud., Nomencl., ed. 2. 4. 661. 1854. *nom. nud*. — *Nelumbo nucifera* Gaertn. α *speciosa* (Willd.) O.K., Revis. Gen. Pl. 1: 12. 1891, *nom. inadmiss.* — *Nelumbium nelumbo* (L.) Druce, Rep. Bot. Exch. Cl. 3. 421. 1914. — *Nelumbo caspica* (Fisch.) Schipcz, Acta Hort. Petr. 63. 314, f. 325. 1930. Type: India, herb. *Linn. 673.7* (Microf.!) (holotype: in Malabaria, Rheede, Hort. Malab. 11: t. 30 1692); India, *Adanson s.n.* (syntype P)

Doubtful names

Nelumbo javanica Poir., in Lamarck, Encycl. 4: 454. 1797. — Type: Indonesia: Java:

Nelumbo alba Berchtold & J. Presl, Prir. Rostlin Nelumbiaceae 2. 1823.

Nelumbo caspica Eichwald, Pl. Nov. 2. 1831.

Nelumbium venosum Presl, Rel Haenk. 2. 83. 1835.

Nelumbium transversum Presl, Reliq. Haenk. 2: 83. 1835. — *Nelumbium turbinatum* Blanco, Fl. Fillp. 458. 1837.— Type: Philippines: habitat in insola Luzon.

Nelumbium discolor Steud. Nomencl., ed 2, 3. 188. 1841. — Type: habitat China.

Tamara hemisphaerica Buch.-Ham. Ex Pritzel, Ic, Bot, Index I 1087. 1855. Reede Hort. Mal. 9, 79

Nelumbo nelumbo (L.) H. Karst. Deut. Fl. 553. 1882, *nom. inadmiss.*

Leaf blades flat when floating, somewhat concave when emersed, orbicular, 10–100 cm. in diam., entire, glabrous and glaucous on both surfaces, dark green above, paler beneath, coriaceous, membranous when dry; petioles up to 2 m long, beset with scattered hard minute papillae. **Flowers** 8–25 cm in diam., rose-pink or white, fragrant; hypogynous. Peduncles up to 2 m long, beset with scattered hard minute papillae. **Sepals** 4–5 or more, ovate or elliptic, 1.5–5 by 0.8 –3.5 cm concave, green (in white flowers) or pinkish green (in rose-pink flowers), caducous. **Petals** ca. 20 (single form) or ca. 110 (double form), each elliptic, obtuse or subacute, concave, 4–15 by 2–8 cm, gradually becoming obovate to spathulate. **Stamens** up to 225, each one 2.2–4.5 cm long; outermost ones in double form staminodial. Filaments linear to ovate or obovate, 7–25 mm long. Anthers linear, 15–20 mm long, yellow, with 4 pollen-sacs, connective with white or yellow-white appendage, 4–8 mm long. Receptacles 2–4 cm across, spongy, yellow during anthesis, turning green and finally becoming dark brown and 5–10 cm across in fruit. **Ovary** of 12–30 free carpels embedded in the truncate surface of the enlarged obconical receptacle, ellipsoid or fusiform, ovule solitary, ventral-apical. Capels 8–10 by 2–3 mm becoming ca. 2 by 1 cm in fruit. Style absent or modified into abaxially projecting carpellary appendages. Stigma sessile, yellow, papillate, ca. 1 mm across. **Fruit** glabrous or elongate ovoid, with the carpel wall adnate to the testa forming a hard-walled nut embryo with two thick and fleshy cotyledons surrounding a green plumule (Figure 37-38).

Specimen studied:

Flower rose-pink: — NORTHERN: Chiang Rai. Mueang district, *R. Pooma 712*; Nong Bong Khai Non-hunting area, *W. La-ongsri 300* (QBG); Nong Leng Sai, *W. La-ongsri 316* (QBG); Nong Luang, Mae Chan district, *W. La-ongsri 317, 342* (QBG); Waeng Chai district, Nong Thao, Tambon Don Sila, *W. La-ongsri 341* (QBG).

Lamphun. Mueang District, Ban Mueang Nga, 300 m, *Brun Bjørnland/Schumacher 439 (*C*)***.*** **Nakhon Sawan.** Bueng Borapet, *W. La-ongsri 291* (QBG). **Phayao**. Kwan Phayao, *W. La-ongsri 299, 315* (QBG). **Lampang**. Mae Mao reservoir, *W. La-ongsri 339* (QBG); Mae Tha district, Nam Jang river, Ban Luk Tai, *W. La-ongsri 349* (QBG). **Nan**. Huai Cham Dea, Ban Sanean, *W. La-ongsri 343* (QBG). — **NORTH-EASTERN: Sakon Nakhon.** Nong Haan, *W. La-ongsri 258* (QBG). **Nong Khai.** Bueng Khong Long Wildlife Sanctuary**,** *W. La-ongsri 262* (QBG)**. Khon Kaen.** Phon district, Ban non hawm, Pek yai, 174 m *W. La-ongsri 272* (QBG); Waeng Yai district, Ban Kud Mak Hep, *W. La-ongsri 326* (QBG). **— EASTERN: Buri Ram.** Huai Talad Reservoir Non-hunting area, *W. La-ongsri 270, 321* (QBG); Huai Chorakaemaak reservoir Widlife Sanctuary, *W. La-ongsri 319* (QBG). **— CENTRAL: Suphan Buri.** Bang Pla maa district**,** *W. La-ongsri 309* (QBG). **Chai Nat.** Tambon Tha kham, *W. La-ongsri 310* (QBG). **— SOUTH-EASTREN: Rayong.** Klaeng district, *W. La-ongsri 287* (QBG). **SOUTH-WESTERN: Prachuap Khiri Khan.** Khao Sam Roi Yot National Park, *W. La-ongsri 223, 336* (QBG). **— PENINSULAR: Phatthalung**.Tha Lae Noi Non-hunting area, *W. La-ongsri 229, 333* (QBG). **Narathiwat.** Klai Ban reservoir, Phi Khul Tong, *W. La-ongsri 238* (QBG).

Flower white: — NORTHERN: Chiang Mai*, A. F. G. Kerr 1362* (K). **Lampang.** Hang Chad district, Nong Kham, *W. La-ongsri 351* (QBG). **Nakhon Sawan.** Bueng Borapet, *W. La-ongsri 290* (QBG). **— NORTH-EASTERN: Sakon Nakhon.** Nong Haan, *W. La-ongsri 260* (QBG). **Nong Khai.** Bueng Khong Long Wildlife Sanctuary**,** *W. La-ongsri 263* (QBG). **— EASTERN: Buri rum.** Kok Laam Reservoir, Lam Phay Maas district, *W. La-ongsri 269* (QBG). **— CENTRAL: Chai Nat.** Manorom District, Ban Dakkhanon, *W. La-ongsri 297* (QBG). **Pathum Thani.** Tambon Naa Mai, Lad lum kaew, *W. La-ongsri 308* (QBG). **— SOUTH-EASTREN: Rayong.** Klaeng district, *W. La-ongsri 285* (QBG). **— SOUTH-WESTERN: Prachuap Khiri Khan.** Khao Sam Roi Yot National Park, *W. La-ongsri 224* (QBG). **PENINSULAR: Songkla**. Hamilton and Congdon 161 (BKF)**;** Ban naam noi ca. 50 m., *W. La-ongsri 231* (QBG). **Phatthalung**. Tha Lae Noi Non-hunting area, *W. La-ongsri 228, 334* (QBG). **Narathiwat**. Klai Ban reservoir, Phi Khul Tong, *W. La-ongsri 244* (QBG).

Distribution: — Thailand throughout all regions (Figure 39), India, South and East Asia to Russia and northern Australia.

Vernacular. — Bua luang (บัวหลวง), Flower pink: Phatum (ปทุม), Bua leam Daeng (บัวแหลมแดง); Flower white: Buntharik (บุณฑริก), Bua leam khaw (บัวแหลมขาว)

Uses: — As ornamental plant, used for religious and decorative purpose, and also edible, in indigenous system of medicine and sold in markets.

Figure 37. *Nelumbo nucifera* Gaertn.

A. Phatum; B. Buntharik; C. habitat and habit; D. Flower l. s. E. leaf; F. pod.

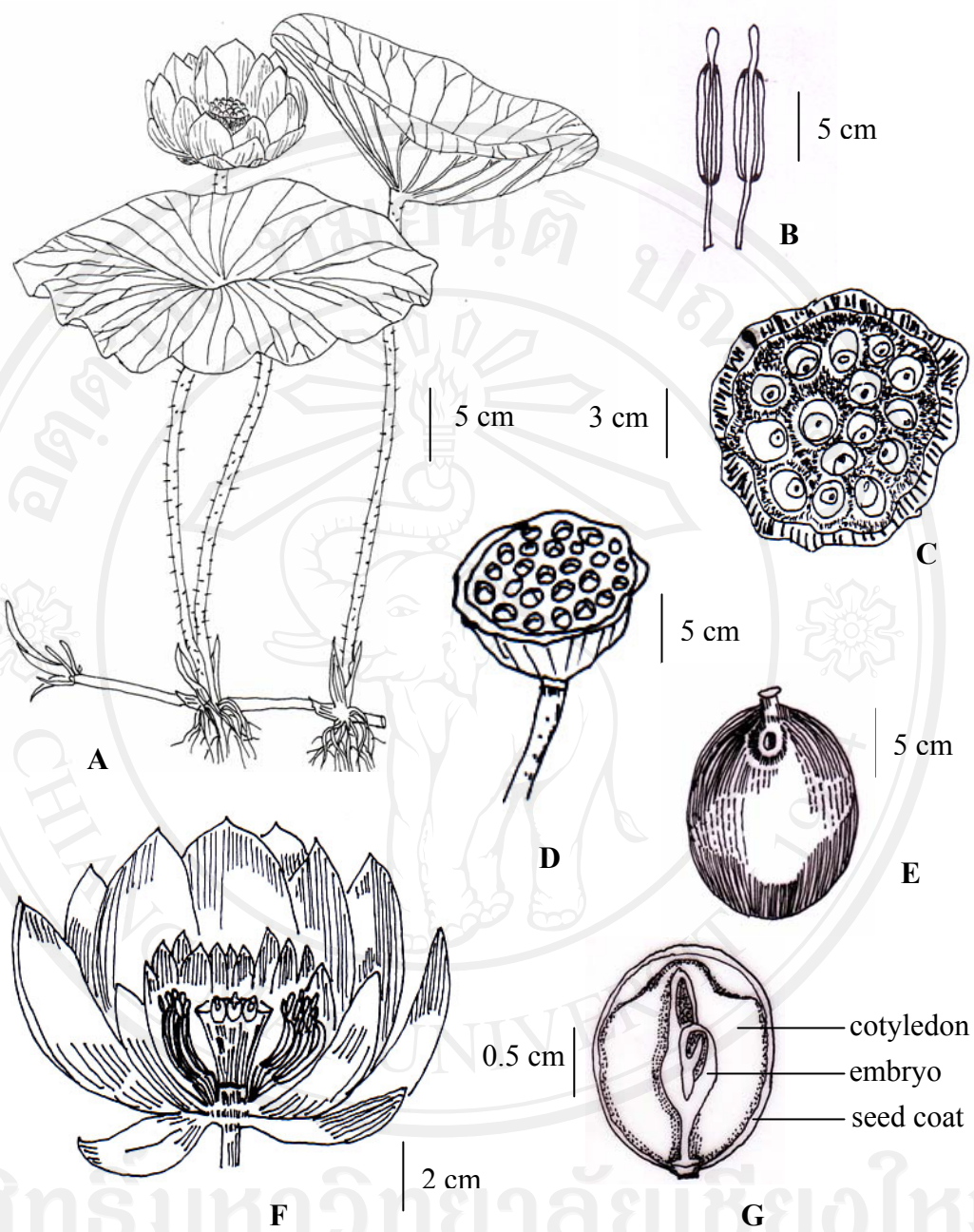

Figure 38. Line drawing of *Nelumbo nucifera* Gaertn.
A. habit; B. stamen; C. fruit top-view; D. fruit; E. seed; F.flower long-section; G. seed showing embryo.

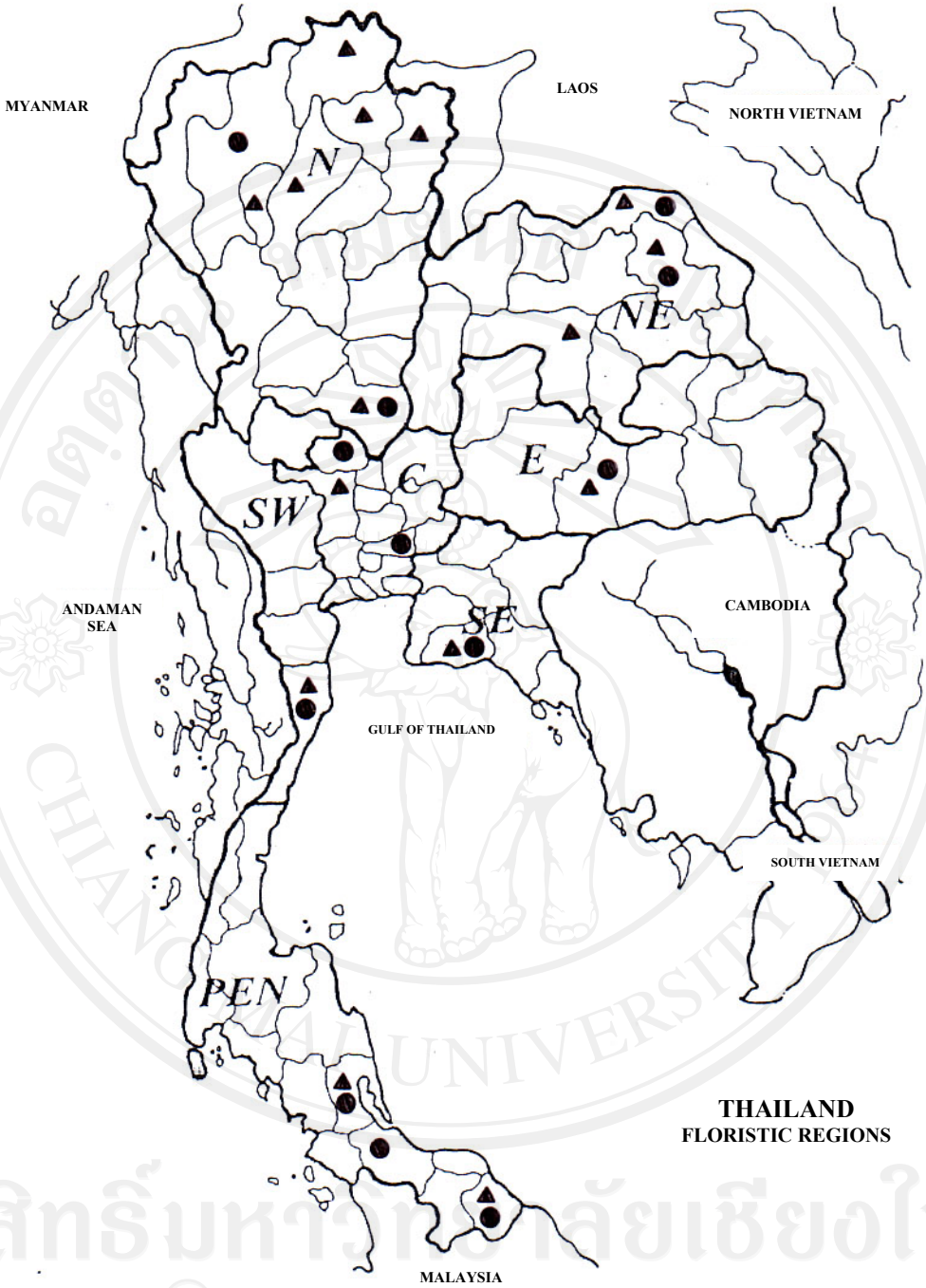

Figure 39. Distribution of *Nelumbo nucifera* Gaertn. in Thailand. ▲= Red flower ●= White flower.

Cultivated species

Nelumbo nucifera varies genetically in flower-color and petal-number, and in addition flower size, blooming-season, plant-height and leaf-size vary fenotypically (Watanabe, 1990). There is a red-flowered form and the petals of some have darker red lines, or they are dark red at the apices of the petals; then there is a white form, and an intermediate white-red form. The red form is more common than the white and intermediate white-red forms and the one with red petal apices is very rare. Flowers with less than 25 petals are usually called single-flowered, those with 25–50 petals are called intermediate, and those with over 50 petals are called double-flowered, but since the petals are not verticillate, a clear distinction between "single" and "double" flowers cannot be made (Watanabe, 1990). Stamens of the intermediate and double-flowered forms often turn into petals, so the number of petals increases.

Traditionally there were only single-flowered *Nelumbo nucifera* in Thailand, and it is believed that the double flowered form was introduced for cultivation by traders or refugees from India or Java for use in ceremonies related to immortality. This suggestion is supported by the fact that the double flowered *Nelumbo nucifera* occurs in wetlands near urban centers and is not found in rural areas (Winitvanandon, 1940, cited in Suvatti, 1988; Kayrat, 1997; Chomchalow, 2007). All flower and color forms now have Thai names (Table 3).

Table 3. Thai names of *Nelumbo nucifera* recorded at 53 localities throughout Thailand and mentioned in Sinthusan (1982) and Lakhakul (1992).

	Flowered form	
Flower Color	**Single**	**Double**
Red	Phatum Phatama Bua luang daeng Bua lam daeng Goganod	Satta bongkot Bua chat sae chompuu
White	Buntarik Bua luang khao	Sattabut Bua chat sae khao

A. *Flower rose-pink, the petals numerous, staminodes become petal like*

***1. Nelumbo nucifera* 'Roseum Plenum'**

Flower large, to 20 cm in diam., red and double, ovate when in young bud, and with 100–130 petals of which the outer ones are wide and greenish (Figure 40 A).

Specimens studied: — NORTHERN: Chiang Rai. Waeng Chai district, Nong Tao, Tambon Don Sila, *W. La-ongsri* 379 (QBG). **Chiang Mai**. San Sai district, Tambon Pha Phai, *W. La-ongsri 382* (QBG). **— SOUTH-EASTERN: Chon Buri.** Phanatnikhom district, *W. La-ongsri 370* (QBG).

Distribution: — Thailand cultivated throughout all regions, India, China and Japan
Vernacular: — Satta bongkot (สัตตบงกช), Chat daeng (ฉัตรแดง), Bua chat chompu (บัวฉัตรชมพู)
Use: — Flowers are used as ornamentals and for religious ceremonies.

B. *Flower creamy white, petals numerous, staminodes becomes petal like*

***2. Nelumbo nucifera* 'Album Plenum'**

Flowers large, creamy white and double, 20–25 cm in diam. and with 100–130 petals. The stamens often turn into petals so the number of petals increases and the outer petals are wide and greenish. Flowers fragrant (Figure 40 B).

Specimens studied: — NORTHERN: Chiang Rai. Waeng Chai district, Nong Tao, Tambon Don Sila, *W. La-ongsri* 378 (QBG). **Chiang Mai**. San Sai district, Tambon Pha Phai, *W. La-ongsri 380* (QBG); Mae Rim district, Ban Wang Pong, *W. La-ongsri 381* (QBG). **— SOUTH-WESTERN: Phetchaburi**. Tambon Nong Pap, *W. La-ongsri 383* (QBG). **— CENTRAL: Suphan Buri.** Song Phe Nong district, Ban Moo Koh, *W. La-ongsri 384* (QBG). **Nakhon Phatom.** Phutthamonthon district, Mahasawat, *W. La-ongsri 385* (QBG). **Nonthaburi.** Bang Yai district, Tambon Bang Yai, *W. La-ongsri 386* (QBG). **— SOUTH-EASTERN: Chon Buri.** Phanatnikhom

district, *W. La-ongsri 369* (QBG). **— PENNINSULAR: Phatthalung.** Kuankhanoon district, Tambon Thale noi, *W. La-ongsri 335* (QBG).

Distribution: — Thailand cultivated throughout all regions, India, China and Japan
Vernacular: — Sattabut **(**สัตตบุษย์**),** Bua chat khao (บัวฉัตรขาว)
Use: — Flowers used as ornamentals and for religious ceremonies.

Figure 40. Cultivated forms of *Nelumbo nucifera* Gaernt.
A. Satta bongkot; B. Sattabut.

3. NYMPHAEACEAE

Key to the genera of Thai Nymphaeaceae

1. Petals connate into a lobed tube; stamens attached to corolla tube; corolla tube epigynous, arising around the top of the ovary, but the sepals hypogynous; leaves submerged and erect sometimes floating ***Barclaya* Wall.**

1. Petals free; stamens free from the petals; mature leaves usually floating ***Nymphaea* L.**

Barclaya Wall.

Barclaya Wall., Trans. Linn. Soc. London 15: 443, t. 18. 1827. ― *Hydrostemma* Wall. In Taylor and Phillips, Phil. Mag. n.s. 1: 454. 1827. Type. *Barclaya longifolia* Wall.

Rhizomatous herbs; leaves with the petiole inserted at the broader and notched end of the blade. **Leaves** alternate; membranous; long petiole; simple; lanceolate to orbicular; cross-venulate; cordate; margins entire. **Flowers** perigyneous to epigyneous; distal portion of gynoecium cup-shaped and covered with stigmatic tissue. **Sepals** 4–5; 1 whorled; polysepalous (borne beneath the ovary, the oblong sepals long-mucronate); regular. **Petal** 12–50 (to many); lobes more or less distinctly 3–4 whorled on the tube; gamopetalous; regular; persistent. **Stamens** about 20–30; pendulous and attached to the inner surface of a corolla tube extended above the stigmatic cup; filaments short. Anthers basifixed; non-versatile; dehiscing via longitudinal slits; bilocular; tetrasporangiate. Staminodes about 15–20**. Ovary** 8–14 locular. Gynoecium very shortly stylate. Styles 1; apical. Stigmas 1; forming an obscurely radiate disk with a central, conical projection. Placentation laminar, the ovules scattered over the partitions. Ovules 30–50 per locule; over the carpel surface; non-arillate; orthotropous; bitegmic; crassinucellate. Endosperm formation cellular**. Fruit** fleshy; indehiscent; a berry (globose, crowned by the persistent corolla, with sweet, rose coloured flesh). **Seeds** endospermic; perisperm present. Seeds densely, rather softly spinulose. Embryo well differentiated (minute). Cotyledons 2.

Taxonomic History of *Barclaya*

Shortly after arriving to Rangoon on Wallich's trip to Burma in 1826 N. He was presented with a water lily from Pegu which he immediately realized was different from other *Nelumbo, Nymphaea, Euryale* and *Nuphar* which were the genera of Nymphaeaceae known at the time. Wallich quickly wrote up a description, made a drawing and commented on the plants and its peculiarities and sent this description to H.T. Colebrooke, a director of the East India Company and a member of the Linnean Society. The new genus and species had been named "*Hydrostemma linguiforme"* in the manuscript and also on the herbarium sheets that are now kept in Wallich's herbarium at Kew (K-W) and at the British Museum (BM). The paper was read to the Linnean Society on 1st of May 1827, and the meeting was duly reported in the *Philosophical magazine* n.s. 1: 454 in June of 1827 but with only the generic description included. In December of 1827 the full paper was published in the *Transactions of the Linnean Society of London*, but now the generic name had changed to *Barclaya* and the single species was named *B. longifolia.* Mabberley (1982) who disentangled this series of event and gave some possible reasons for them, argued that *Hydrostemma* should be reinstated. But these species are used by thousands of aquarists and mentioned in a large number of scientific and popular publications which prompted Crusio and Bogner (1984) to make a formal proposal to conserve the name *Barclaya* against *Hydrostemma,* a proposal which has been approved by the Botanical Congress in Berlin.

Especially the floral structure of *Barclaya* is unusual in the Nymphaeaceae. The flower has five sepal-like bracts below the ovary, and a tubular perianth enclosing the ovary in its lower part. There are many epipetalous stamens on the upper inner part of the tubular perianth, while about ten confluent carpels that are prolonged into a style forming a ten-rayed cone on which the inner surface is stigmatic (Hu 1968; Li, 1955, illustrated in Caspary, 1891).

Barclaya now has four known species which all grow in shaded forests in Indomalaysia, Thailand and Burma, three of which are aquatic, growing in small, clear, slow-moving streams (Ridley, 1967; Stone, 1979), the fourth, *B. rotundifolia* Hotta, in marshy areas and producing aerial leaves (Schneider and Williamson, 1993). Only two species have been recorded in Thailand. *Barclaya longifolia* has been found

in the natural wetland and the other – *Barclaya motleyi* – is known from a single herbarium specimen.

Key to the Thai species of *Barclaya*

1. Leafblades broadly ovate, 3–9 by 3–8 cm, subcoriaceous, grayish tomentose and brownish-yellow tomentose on midrib and veins below. **1. *B. motleyi***
1. Leaf blades linear-oblong, 12–28 by 2–6 cm, membranous, puberulous or glabrate below. **2. *B. longifolia***

1. *Barclaya motleyi* Hook. f.

Barclaya motleyi Hook. f., Trans. Linn. Soc. London 23: 157. t. 21.1860. Type: Indonesia: Kalimantan Bangarmassing, 1857. *Motley* 956 (holotype K!); Malaysia: Sarawak, 1857. *Lobb s.n.* (syntype K!)

Leaves broadly ovate, 3–9 by 3–8 cm, apex round, base cordate, subcoriaceous when dry, finely punctuate above and coarser on midrib, grayish tomentose and brownish yellow tomentose in midrib and veins below; margins undulate-crispate. Petioles 6–18 cm long, pubescent. **Flowers** 1.5–3 cm long, pink, hardly expanding and emerging above water; peduncles 5–15 cm long. **Sepals** 3–4 by 0.3–0.6 cm, linear-elliptic, concave, subulate and sometimes falcate, densely yellowish-brown or grayish woolly on outside, glabrous inside, brown. **Petals** shorter than sepals, brownish green, brown, pinkish-red, the free parts lanceolate but sometimes ovate at base, inserted on the tube, entirely glabrous. **Stamens** 1.5–2 mm long (inner ones), curved inwardly, adnate to the corolla-tube, outer ones staminodial, the free parts of the filaments very short or absent, ca. 0.2 mm long or less, becoming longer in the more apical (=outer) stamens, anthers oblong, curved downward and inward, antheroids becoming progressively smaller towards the outer ones and less distinct as such. **Ovary** superior, obconical, style absent, stigmatic appendage ovoid, cordate. **Fruit** a berry 1–1.5 cm in diam. **Seeds** elliptic, about 1 mm in diam. at either end with a bundle of hairs, for the rest with scattered soft spinulose hairs all over.

Specimens examined: — **Thailand.** without clear locality, *M. C. Lakshnakara 788* (BK, K), (Figure 41)

Distribution: — Sumatra, Borneo, New Guinea, India, Indonesia, Malaysia.

Vernacular. **—** Not known.

Uses: — Not known.

Figure 41. *Barclaya motleyi* Hook. f. on herbarium sheet.

2. *Barclaya longifolia* Wall.

Barclaya longifolia Wall., Trans. Linn. Soc. London 15: 443. t. 18. 1827. **—** *Hydrostemma longifolium* (Wall.) Mabberley, Taxon 31: 68. 1982. Type: Myanmar: Pegu near Rangoon, August, 1826. *Wallich, num. list, 7260* (CAL *n.v.,* K-W *n.v.,* BM *n.v.*).

Leaf blades linear-oblong, 12–28 by 2–6 cm, apex obtuse, base cordate-subsagittate, membranous, puberulous or glabrate below; margins undulate-crispate. Petioles 6–25 cm long, puberulous or glabrescent. **Flowers** 1.5–2.5 cm long, purplish, hardly expanding and emerging above water; *peduncles* 10–35 cm long. **Sepals**

linear-elliptic, 1.5–2.5 by 0.5–0.6 cm, concave, obtuse, midrib distinct distally and produced into a 3–5 cm long tail, below greenish-purple, above purplish. **Petals** shorter than sepals, below sap-green, above purplish, lobes broadly or narrowly oblong. **Stamens** 2–2.5 mm long (inner ones), curved inwardly. **Ovary** superior, 6–12 locular, style absent, stigmatic appendage curved over stigmas. **Fruit** a berry 1–1.5 cm in diam. **Seeds** about 1 mm in diam., brown, globose, spinulose, spines radiating, tufted at micropylar region. (Figures 42, 43)

Specimens examined: — NORTH-EASTERN: Nong Khai. Bang Son, *Put 1567* (BK, K); Bung klaa, Phutoknoi, *C. Niyomdham 5090* (AAU, BKF); Bungkhla District, Nature trail from headquarter, Phu Wua Wildlife Sanctuary, 200 m, *R. Pooma, W. J. J. O. de Wilde, B. E. E. Duyfjes, V. Chamchumroon, K. Phattarahirankanok 2781* (BKF, L, GH). **Sakon Nakhon.** Aang Kob, Phu Phan National Park, 200 m, *W. La-ongsri 216* (QBG). **— EASTERN: Ubon Ratchatani**. Huay Yang subdistrict, Gene Conservation Station, near Bahai Village, 150 m, *J. F. Maxwell 01-436* (MO); Soi Sawan Waterfall, Pha Thaem National Park, ca 250 m, *W. La-ongsri 220, 322* (QBG). **— CENTRAL: Saraburi.** Salun Lalue, *J. F. Maxwell 73-503* (AAU). **— SOUTH-EASTERN: Chanthaburi**. *K. Larsen, T. Smitinand and E. Warncke 1746* (AAU, BKF). **Trat.** Salak Kawk, Koh Chang, *Kerr 9226* (BK, C, K, L). **— PENINSULAR: Phangnga.** 15 km N of Takuapa evergreen forest, 50–150 m, *K. Larsen, S. S. Larsen, I. Nielsen and T. Santisuk 30887* (AAU, BKF, L). **Surat Thani.** Pha Mai Daeng, Nasan district, *Sanan 356* (BKF). **Satun.** Tarutao Island, *C. Chermsirivathana and Kasem 1480* (BK). **Pulau Langkawi**. *H. Keng et al. K.6151* (AAU).

Distribution: — Eastern and southern part of Thailand (Figure 44), Myanmar, eastern Malaysia, and India.

Vernacular: **—** Sai Pl alai (ไส้ปลาไหล), Lin fan (ลิ้นฟาน), Karak Chang (การักช้าง)

Use: — *Barclaya longifolia* is popularly grown in aquaria in Europe and N America and it is a highly prized aquarium plant due to colour variation of the blade (Crusio and Bogner, 1984; Schneider and Williamson, 1993).

Figure 42. *Barclaya longifolia* Wall.

A. flowers, hypogynous sepals floating on water; B. fruit l.s., showing petals connate into lobed tube and stamens attached to epigynous corolla tube, and spiny seeds; C. fruit, external view; D. mature spongy fruit splitting irregularly after ripening; E. fruit, x.s; F. habitat, slow stream in tropical rain forest; G. habit. (photo: W. La-ongsri, A, D, F-G, in Ubon Ratchathani, H. Balslev B-C, E in Ubon Ratchathani).

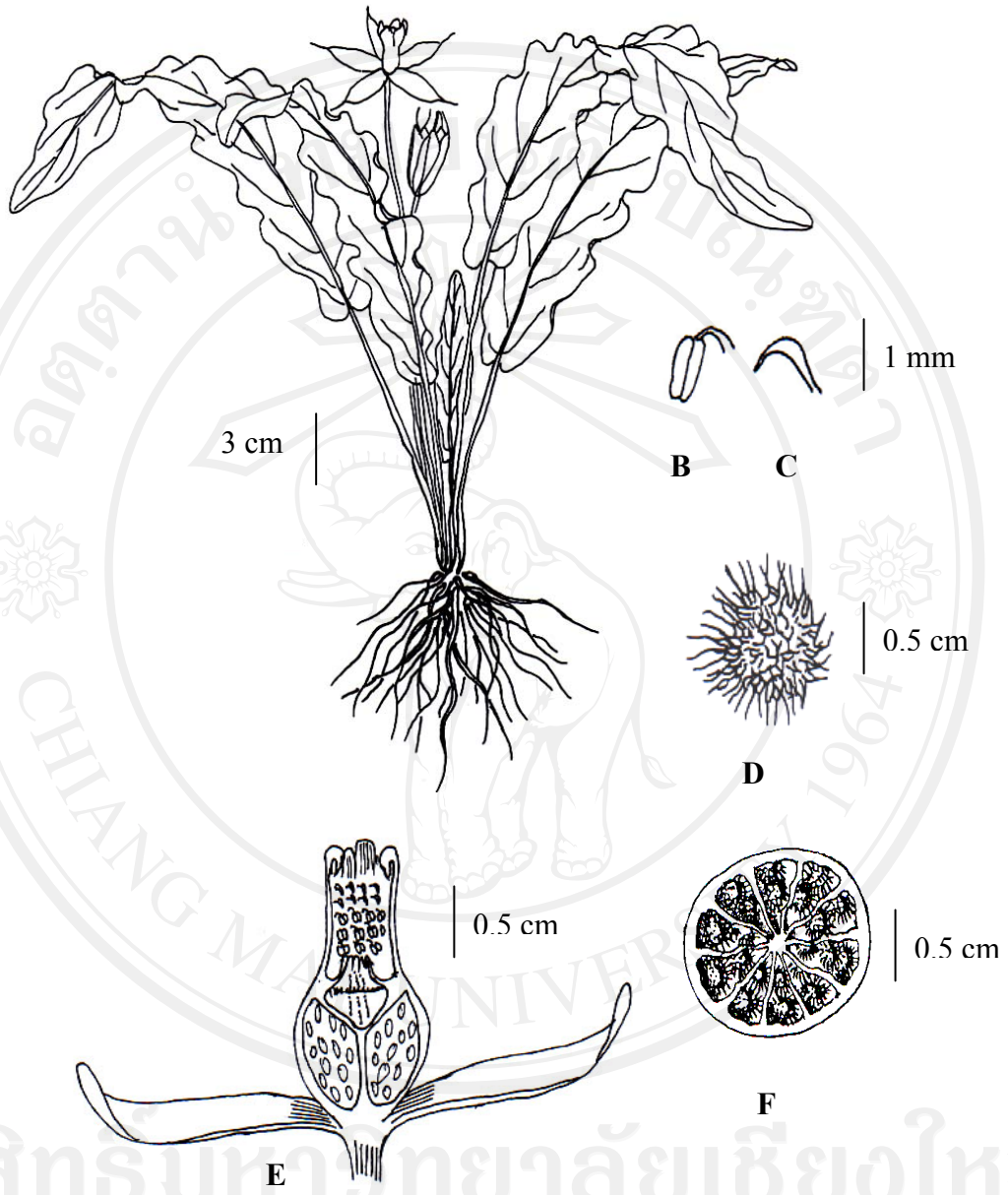

Figure 43. Line drawing of *Barclaya longifolia* Willd.
A. whole plant; B. fertile stamen; C. sterile stamen; D. seed; E. flower long-section; F. ovary cross-section.

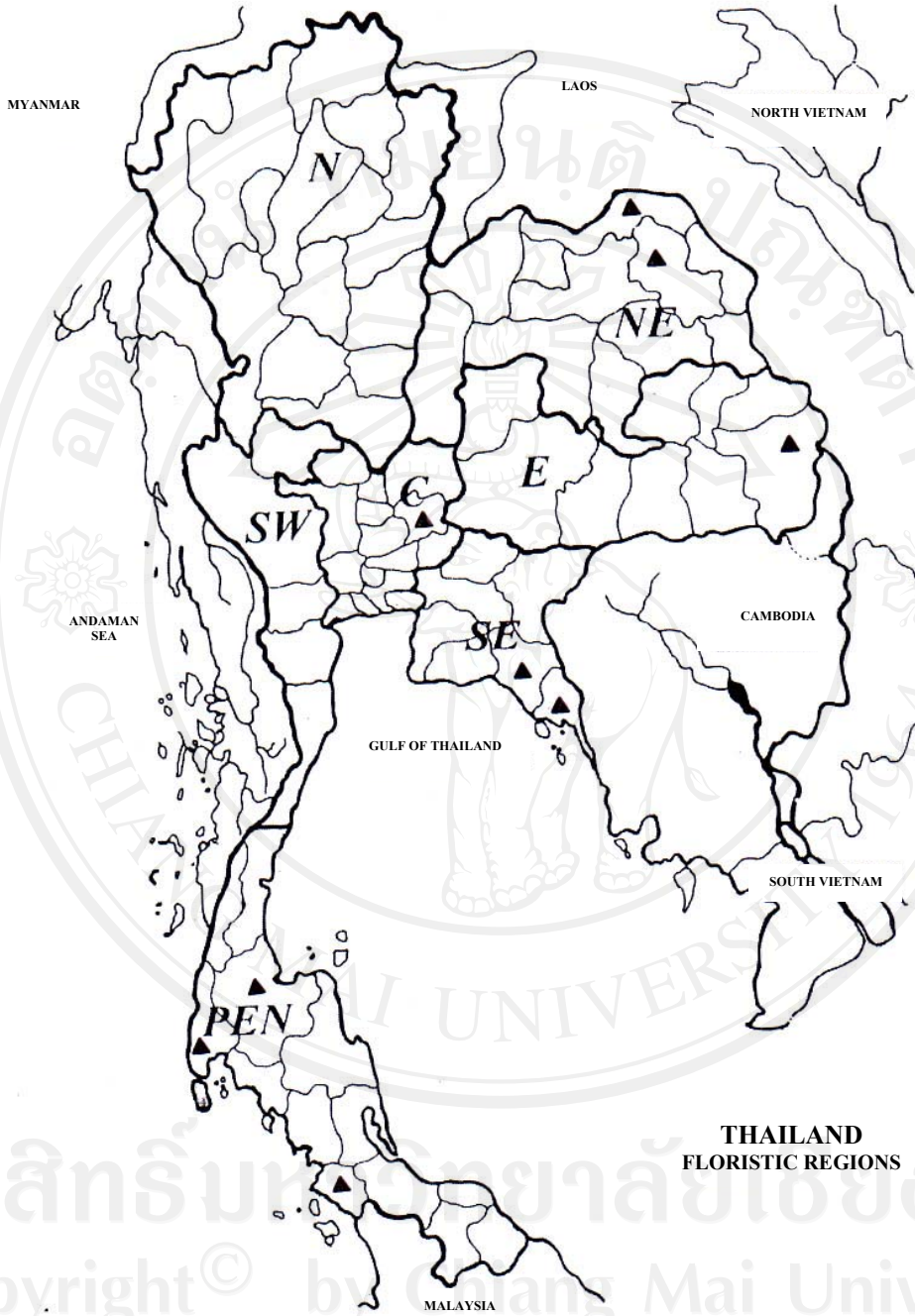

Figure 44. Distribution of *Barclaya longifolia* Wall. in Thailand.

***Nymphaea* L.**

Nymphaea L., Sp. Pl.: 510. 1753. ― *Castalia* Salisbury, Ann. Bot. (König and Sims) 2:71. 1806.― *Leuconymphaea* Ludwig (Def. Gen. Pl. (1737) 69) O.K., Rev. Gen. Pl. I, 2 (1891). Type. *Nymphaea alba* L.

Perennial herbs with rhizomes. **Leaves** orbicular, peltate or subpeltate, margins entire, dentate or crenulate; base cordate or sagittate, main veins radiating from the top of the petiole; petiole inserted at the broader and notched end of the blade. **Flowers** actinomarphic, large and conspicuously colored, often fragrant. **Sepal** 4, rarely 5, hypogynous, adnate to the badt of the torus. **Petals** numerous**,** free, hypogynous or epigynous. **Stamens** perigyneously attached to a floral cup; distal portion of gynoecium cup-shaped and covered with stigmatic tissue, numerous, filaments either narrower or broader than anthers, usually oblong or linear,connective with or without appendage, anthers linear and introrse. **Ovary** superior, many cells, arranged in a whorl, septa single or double, ovules numerous, anatropous on superficial placentation, placentas lamellate. Style absent. Stigma radiate, as many as cells of ovary, free of connate at adaxial end, with or with out abaxial appendage. Floral axis present as a small projection at the base of the stigmatic cup. **Fruits** spongy berry, many seed, ripening under water. **Seed** smooth or with papillar outgrowths or hairs, arillate, with perisperm and starchy endosperm.

Nymphaea is cosmopolitan and includes some 50 species. Based on the degree of carpel fusion, the length of carpellary appendages and whether the plants are night blooming or day blooming Caspary (1891) divided *Nymphaea* into six subsections in two sections. Conard (1905) and later Schneider and Williamson (1993) reduced these to five subgenera of which two are represented in Thailand (Table 4).

Table 4. The five subgenera of *Nymphaea* and their characters as defined by Conard (1905) and Schneider and Williamson (1993). The species mentioned are representative; those marked with* are the Thai species.

Subgenus	**Carpels fusion**	**Carpellary appendages**	**Anthesis**	**Species**
Lotos	Complete	Well developed	Nocturnal	*N. lotus* *N. thermalis* *N. dentata* *N. pubescens** *N. rubra** *N. capensis**
Hydrocallis	Complete	Well developed, clavate	Nocturnal	*N. rudgeana* *N. amazonum*
Nymphaea (=*Castalia*)	Complete		Diurnal	*N. alba* *N. candida* *N. odorata* *N. tuberosa*
Brachyceras	Incomplete	Slightly developed, triangular–tapered	Diurnal	*N. coerulea* *N. stellata* *N. cyanea** *N. nouchalii**
Anecypha	Incomplete	Absent or inconspicuous	Diurnal	*N. gigantea*

Key to the native Thai species of *Nymphaea*

1. Petals white, blue or deep purple; stamens with dental sterile appendages; carpels incompletely fused; anthesis diurnal; stigmatic appendages slightly developed, triangular-tapered; leaf blade glabrous, margin entire, subentire, or crenate (***Nymphaea*** subg. ***Brachyceras*** Caspary)
    2. Flower blue; sepals green outside; petals more than12; stamens 33–80. **1. *N. cyanea***
    2. Flower white or bluish–white; sepals green with dark purple streaks outside; petals less than 12; stamens 25–50. **2. *N. nouchali***
1. Petals white to deep red; stamens without dental sterile appendages; carpels completely fused; anthesis nocturnal; stigmatic appendages well developed, linear; leaf blade pubescent beneath, margin dentate and teeth acute to sub-spinose **(*Nymphaea* subg. *Lotos* DC.)**
    3. Petals white or a part of sepals and outer petal with tinge of red toward the outside; anthers yellow; leaf blade ovate to slightly orbicular, dark green above, purple-green with purple spots beneath. **3. *N. pubescens***
    3. Petals deep red; anthers orange; leaf blade orbicular, at first dark-red both above and beneath, becoming greenish above with age. **4. *N. rubra***

1. *Nymphaea cyanea* Roxb.

Nymphaea cyanea Roxb., Fl. ind. 2: 577. 1832. Hort. Beng. 41. 1814, *nom. nud*.— *Nymphaea stellata* Willd. α *cyanea* (Roxb.) J. D. Hook. and Thomson, Fl. Ind. 1: 243. 1855. — *Nymphaea stellata β* Sims, Bot. Mag. t 2058. 1819. Cited in Planchon l.c. 40. 1853. Type: India. Calcutta. Cult, in Hort. Bot. Calcutta (unspecified *s.n.,* NY!)

Leaves elliptic to ovate, 13–39 by 12–32 cm, peltate to sub-peltate, apex rounded or retuse, basal lobes round, obtuse, acute, glabrous, punctuate along the nerves; veins 5–7 pairs, midrib flat above, prominent below, reddish-purple with brown spots beneath; margin crenate or repand. Petioles terete, brown, glabrous; stipules present as a narrow transparent wing on either side of the petiole at the base. **Flowers** 8–20 cm in diam., blue. **Sepals** 4, 9 by 2.5 cm, ovate to lanceolate, apex

obtuse or acute, green outside and glabrous or papillate above, blue. **Petals** 12–18, elliptic-lanceolate to lanceolate, 6.8–9 by 1.2 cm, pale or deep blue, obtuse or subacute. **Stamens** 33–80, 2–5 cm long, yellow with blue appendages, filament broadly lanceolate. **Ovary** 16–20-locular, cells composed of two septa, stigmatic appendages 16–20, triangular-tapered, united at the base, 1–3.5 mm long, oblong, incurved, axile process elongate up to 15 mm, glabrous. **Fruit** 3-5 cm in diam. a globose berry, with remnants of sepals, stamen and stigmas. **Seeds** ellipsoid-globose 0.5–1 mm in diam. with longitudinal ribs, glabrous or conspicuously ciliate along ribs when immature, becoming glabrate with growth of aril (Figures 45-46).

Specimens examined:— NORTHERN: Chiang Mai. 330 m, *A. F. G. Kerr 1396* (K); SW. of Chiang Mai, pool in rice fields, 350 m, *K. Larsen and B. Hansen 6096* (BKF, C); San Kham Phaeng district, Tambon Orn Tai, Ban Pha Phaw Ngam, 170 m, *W. La-ongsri 249* (QBG); Saraphi district, Ban Chai Satan, ca 140 m, *W. La-ongsri 301* (QBG). **Nan.** Phu paeng subdistrict, Ban Nam Kaean, 300 m, *W. La-ongsri 345* (QBG). **Phitsanulok.** Ban Khong Yang, 100 m, *W. La-ongsri 210* (QBG). **Nakhonsawan.** Payuhakhiri, *L. B. and E. C. Abbe, T. Smitinand 9236* (GH). **— NORTH-EASTERN: Sakon Nakhon.** Nong Han, *M. C. Lakshnakara 1000* (BK, K). **Maha Sarakham.** Ban Don Doo, Kantharawichai district, 126 m, *W. La-ongsri 255* (QBG); Kantharawichai district, in rice field, 183 m, *W. La-ongsri 324* (QBG). **Khon Kaen.** Waeng Noi district, Ban Nong Sa Bang, Ra Han Na, 196 m, *W. La-ongsri 275* (QBG). **— EASTERN: Nakhon Ratchasima.** Ban Chum Seng, Korat, *Nui Noe 185* (BK, K). **— CENTRAL: Bangkok.** Bang Bawn, Tonburi, 5 m, *A. F. G. Kerr. 9330* (BK, K, L). **Prathum Thani**. ca 40 m, *T. Smitinand and E. C. Abbe 6163, 6164* (BKF, K).

Distribution: — Northern and northeastern Thailand (Figure 47), Myanmar and India

Vernacular: — Bua khap (บัวขาบ), Pan dam (ป้านดำ), Pan sang khon (ป้านสังก่อน), Dok chang khon (ดอกจั๋งก่อน)

Use: — As ornamental plant in some areas in northeastern Thailand where the young flowers are also used as a vegetable.

Figure 45. *Nymphaea cyanea* Roxb.

A. habitat and habit; B. leaf blade, note crenate margin; C. flower; D. flower l.s., note stamens, each with dental, sterile appendage; E. fruit showing stigmatic appendages; F. fruit x.s. showing incompletely fused carpels (photo: W. La-ongsri, A-C, E–F in Khon Kaen; H. Balslev D, in Sakon Nakhon).

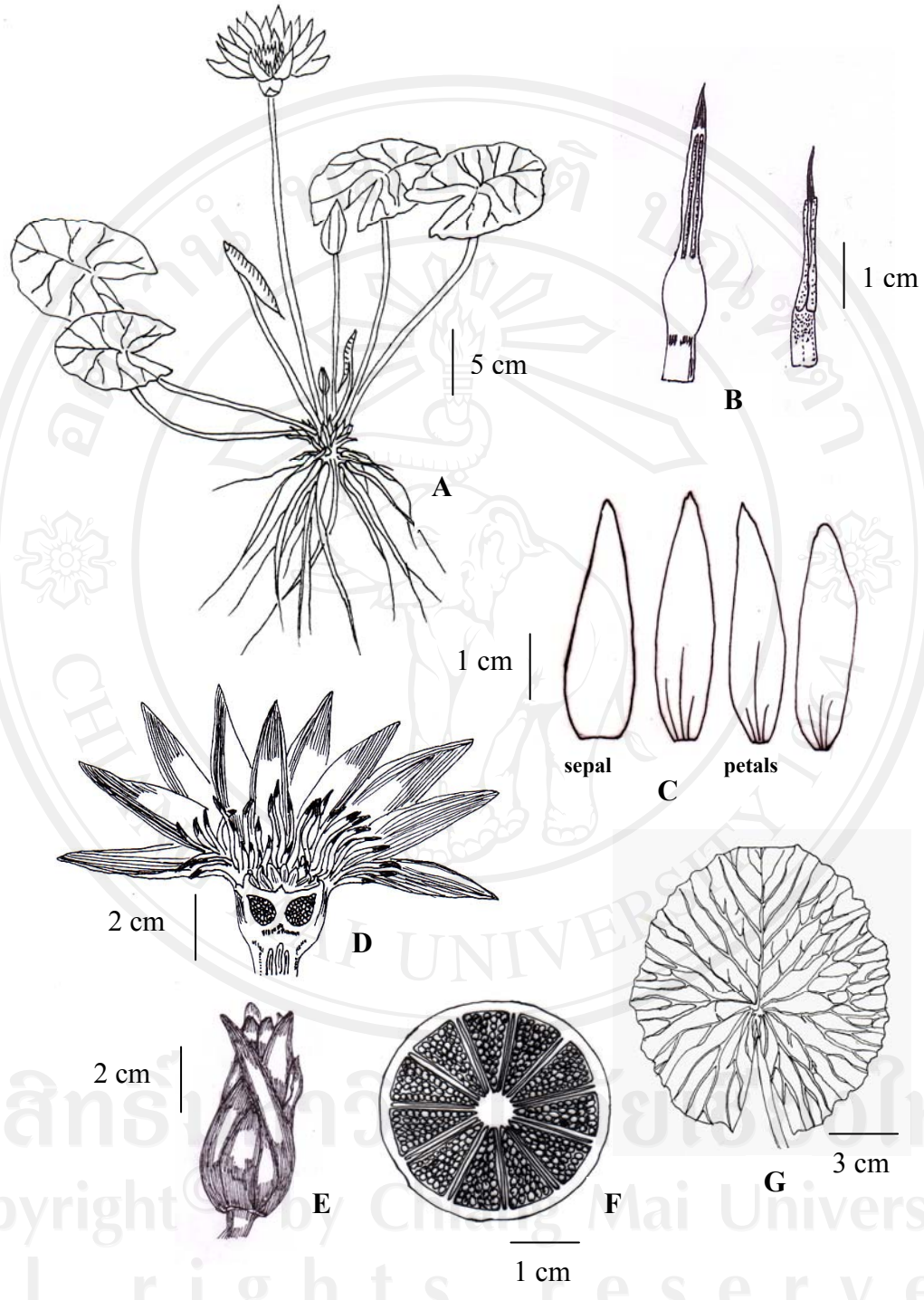

Figure 46. Line drawing of *Nymphaea cyanea* Roxb.

A. habit showing leaves and flower; B. Stamens; C. sepal and petals shape;

D. flower long-section; E. Fruit; F. ovary cross-section; G. leaf.

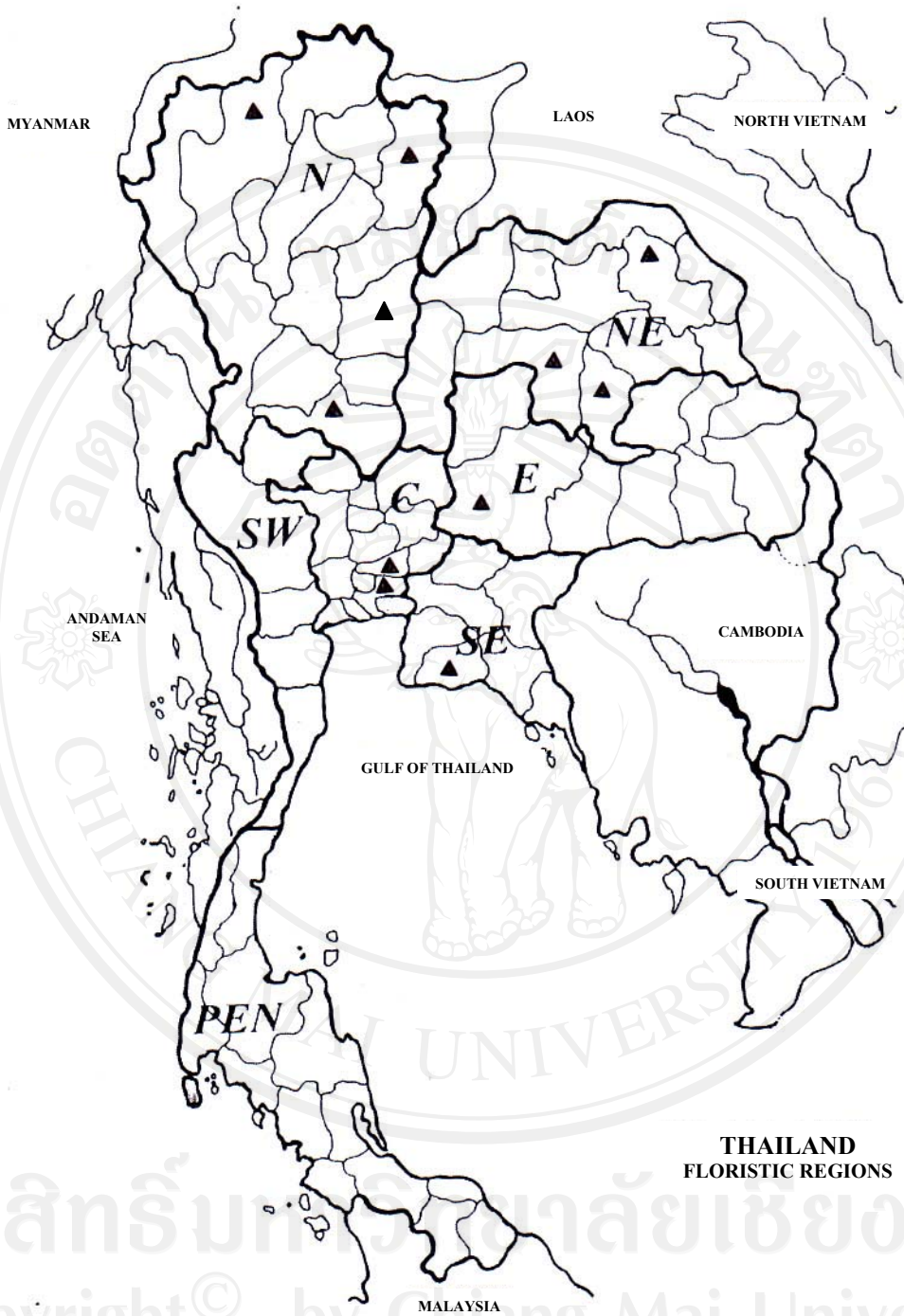

Figure 47. Distribution of *Nymphaea cyanea* Roxb. in Thailand.

2. *Nymphaea nouchali* Burm. f.

Nymphaea nouchali Burm. f., Fl. indica 120. 1768. Type: India. Coromandeli, *Burman* s.n. (holotype K!).

Nymphaea minima F. M. Bailey, Syn. Queensl. fl.:10. 1883. *nom. illeg.* Type: Australia: Queensland; Barron River, *F. M. Bailey* s.n. (holotype BRI 278799).

Nymphaea malabarica Poir. in Lamarck, Encycl., Bot. 4 :457. 1797. ― *Nymphaea stellata* Willd., Sp. pl. 2(2): 1153. 1799. ― *Castalia stellaris* Salisb., Ann. Bot. 2: 72–73. 1806. ― *Nymphaea stellata* Willd. *β parviflora* J. D. Hook. and Thomson, Fl. ind. 1: 243. 1855. ― *Castalia stellata* Blume, Bijdr. 49 1825. ― *Leuconymphaea stellata* (W.) Kuntze, Revis. gen. pl. 1: 11. 1891. Type: India: Malabar, Rheede, Hort. Malab. 11: 53 plate 27. 1692?

Nymphaea versicolor Roxb. In Sims, Bot. Mag. 29: 1189. 1809. ― *Nymphaea stellata* Willd. γ *versicolor* (Roxb.) J.D. Hook. and Thomson, Fl. ind. 1: 243. 1855. Type: India: Bengel, Roxburgh ?

Nymphaea hookeriana Lehm., Hamburger Garten–Blumenzeitung 9: 203, 213. 1853. Type: India. Noapolly, *Hooker and Thomson 19 Dec 1850* [Herb. Lehm in hb. Berlin, K!, fide Conard 1905: 141 =*N. stellata* var. *versicolor*].

Nymphaea punctata Edgew., Trans. Linn. Soc. 20: 29. 1846. [not Kar. and Kir. 1841? fide Conard 1905: 140]. ― *Nymphaea edgeworthii* Lehm., Hamburger Garten-Blumenzeitung 8: 371. 1852. Type: India. Prov. Sirhind. Sádhaura, *M. P. Edgeworth s.n. 1844* (Isotype or holotype K!).

Nymphaea acutiloba DC. Prodr. 1: 116. 1824. *Castalia acutiloba* (DC.) Hand.– Mazz. Symb. sin., 7: 334. 1931. Type: China, “Braam ic. Chin t. 18”

Nymphaea cahlara Donn, Hortus cantabrig. Ed. 7,159. 1812., nom. inval. Type: “E. Indies, July 1809” (CGE?, LIV?).

Nymphaea voalefoka Lat.–Marl. ex W. Watson, Gard. Chron. Ser. 3, 4: 236. 1888 Type: presumably from Madagascar. (?)

Leaves elliptic to ovate, 5–45 by 5–35 cm, peltate to sub-peltate, apex rounded or retuse, basal lobes rounded, obtuse, acute, glabrous, punctuate along the nerves; *veins* 5–7 pairs, midrib flat above, prominent and angular below, above green

and sometimes blotched purple, below reddish purple, brown spotted; margin repand to entire, irregularly sinuate with broad obtuse teeth; petioles terete, 1–5 mm thick, glabrous; stipules present as a narrow transparent wing on either side of the petiole at the base**. Flowers** 4–12 cm in diam., white or bluish-white tinge. **Sepals** four, 2.5–6.5 x 0.7–1.5 cm, lanceolate, to ovate-lanceolate, apex obtube or acute, green with dark purplish streaks outside, glabrous or papillate. **Petals** 8–12, elliptic-lanceolate to oblong-lanceolate, white or bluish-white tinge. **Stamens** 25–50, 1.5–3 cm long, yellow, appendage filament broadly lanceolate, gradually passing into anther. Anther 0.5–1.5 cm, inner stamens longer than filament. **Ovary** 8–21-locular, cells composed of two septa; stigmatic appendages 8–20, united at the base, 1–3.5 mm long, obtuse, incurved, axile process elongate up to 15 mm, glabrous. **Fruit** 3-7 cm in diam., spongy berry, with remnants of sepals, stamens and stigmas. **Seeds** 0.5–1 mm in diam., ellipsoid-globose, with a few longitudinal ribs, glabrous or conspicuously ciliate along ribs when immature, becoming glabrate with growth of aril (Figures 48-49).

Specimens examined: — NORTHERN: Chiang Mai. Mueang district, Jaeng Hua Lin, *Nai Noi Maw s.n.* (BK); Saraphi district, Ban Praya Chom Puu, *W. La-ongsri 302* (QBG). **Kampangpet.** 100 m, *C. Phengklai et al. 3946* (GH). **Nakhon Sawan**. Bueng Borapet, 9 m, *W. La-ongsri 293* (QBG). **— NORTH-EASTERN: Khon Kaen.** Near Thung Brong, *J.F. Maxwell s.n.* (L); Phon district, Ban Non Hawm, Pek Yai, 174 m, *W. La-ongsri 274* (QBG); Waeng Yai District, Ban Kut Mak Hep, Non Sa Ard, 198 m., *W. La-ongsri 327* (QBG); Phon district, Ban Non Hawm, Pek Yai, 174 m, *W. La-ongsri 273*(QBG). **Maha Sarakham.** Kheng Loeng Chan district, Ban Kud Pang, 124 m, *W. La-ongsri 254* (QBG). **Sakon Nakhon.** Nong Haan, 299 m, *W. La-ongsri 259* (QBG). **— EASTERN: Nakhon Ratchasima.** Ban Chum Seng, *Nin Noe 185* (BK, K); Pra Tai district, Ban Nong Sat, *W. La-ongsri 267* (QBG). **Surin.** Chum Phon Buri, *S. Suthisorn, Ying Yong, P. Santivatana 5455 (BK)*. **Amnat Charoen.** Swamp along route. 212 to Ubon Ratchathani, 135 m, *W. La-ongsri 219* (QBG). **Buri Ram.** Huai Chorakhae Mak Reservoir, 156 m, *W. La-ongsri 320* (QBG). **— SOUTH-WESTERN: Uthai Thani.** Nong Kha Yang district, Ban Sum Rong, Tambon Nam Song, *W. La-ongsri 311* (QBG). **Phachuap Khiri Khan.** Sam Roi Yot National Park, 5 m, *W. La-ongsri 223* (QBG). **— CENTRAL: Phra Nakhon Si Ayutthaya.**

Ayuthaya district, Ban Klong Thrai, ca 100 m, *T. Shimizu, H. Toyokuni, H. Koyama, T. Yahara and C. Niyomdham 22178* (BKF); Ayuthaya district, fresh water swamp ca 100 m, *T. Shimizu, H. Toyokuni, H. Koyama, T. Yahara and C. Niyomdham 26093* (BKF, GH). **Nakhon Pathom.** Nakhon Chaisi district, Ban Tha Tam Naak, 95 m, *W. La-ongsri 304* (QBG). **Bangkok**. Near sea level, *A. F. G. Kerr 7841* (K); Bangkok, *A. F. G. Kerr 7861* (BK); Bangkok, *A. Marcan 481* (K.); Bangkok under 5 m, *A. F. G. Kerr 4397* (K); Pakret, Bangkok, *Eryl Smith 258* (BK). **Chai Nat.** Manorom district, Ban Thamma Moon, 85 m, *W. La-ongsri 295* (QBG). **Phathum Thani.** Bang Bua Tong district, Bangkok-Suphan Buri road km 28, Tambon Rahan, 90 m, *W. La-ongsri 307* (QBG). **— SOUTH-EASTERN: Trat.** Koh Chang; *J. Schmidt 246* (BKF, C). **Chon Buri.** Laem Chabang 1 m, *D. J. Collins 1925, 1926* (K); Satthahip district, Toong Brong, sea level, *J. F. Maxwell s.n.* (BK). **Rayong.** Phae district, Phae Arboretum, *T. Shimizu, H. Toyokuni, H. Koyama, T. Yahara and D. Phanichaphol 23380* (BKF); Klaeng district, Ban Nong Bua, sea level, *W. La-ongsri 281* (QBG). **— PENINSULAR: Pattani.** Mueang district, Ban Boo Boh, sea level, *J. F. Maxwell 242* (L) mix with *N. cyanea*. **Surat Thani.** Ban noi, Kong ya, *Yuang 2* (BK); Lang Suan, under 5 m, *A. F. G. Kerr 11923* (BK, L); Kanchanadit ca 40 m, *T. Smitinand s.n.* (BK); Khonom 20 m, *T. Smitinand 83-9* (BKF). **Phatthalung.** Patalung, *J. D. Gwynne Vaughan. 218* (L); Tha Lae Noi Non-hunting area, Kuan Khanoon district, ca 10 m, *Th. S. et al. s.n.* (BKF), *W. La-ongsri 225, 330* (QBG). **Songkhla.** Kra Sae Sin district, Laem Kwai Raap, Tha Lae Sab Wildlife Sanctuary, Ban Fai Raap, Tambon Koh Yai, sea level, *W. La-ongsri 233* (QBG). **Narathiwat**. Bangkuntong, Tak Bai, *C. Niyomdham 629* (BKF); Freshwater swamp-forest south of Naratiwat, 5m, *K. Larsen and S. S. Larsen 33086* (L); Pru Toh Daeng, Tak Bai district, 0–14 m, *W. La-ongsri 239* (QBG).

Distribution: — Throughout Thailand in all regions (Figure 50), Laos, Cambodia, Vietnam, Myanmar, Malaysia, Indonesia, Philippines, Sri Lanka, India, New Guinea and Taiwan.

Vernacular. **—** Bua phuean (บัวเผื่อน), Bua na (บัวนา), Bua be (บัวแป้)

Uses: — As ornamental plants. In some areas in northeastern Thailand the young flowers are used as a vegetable.

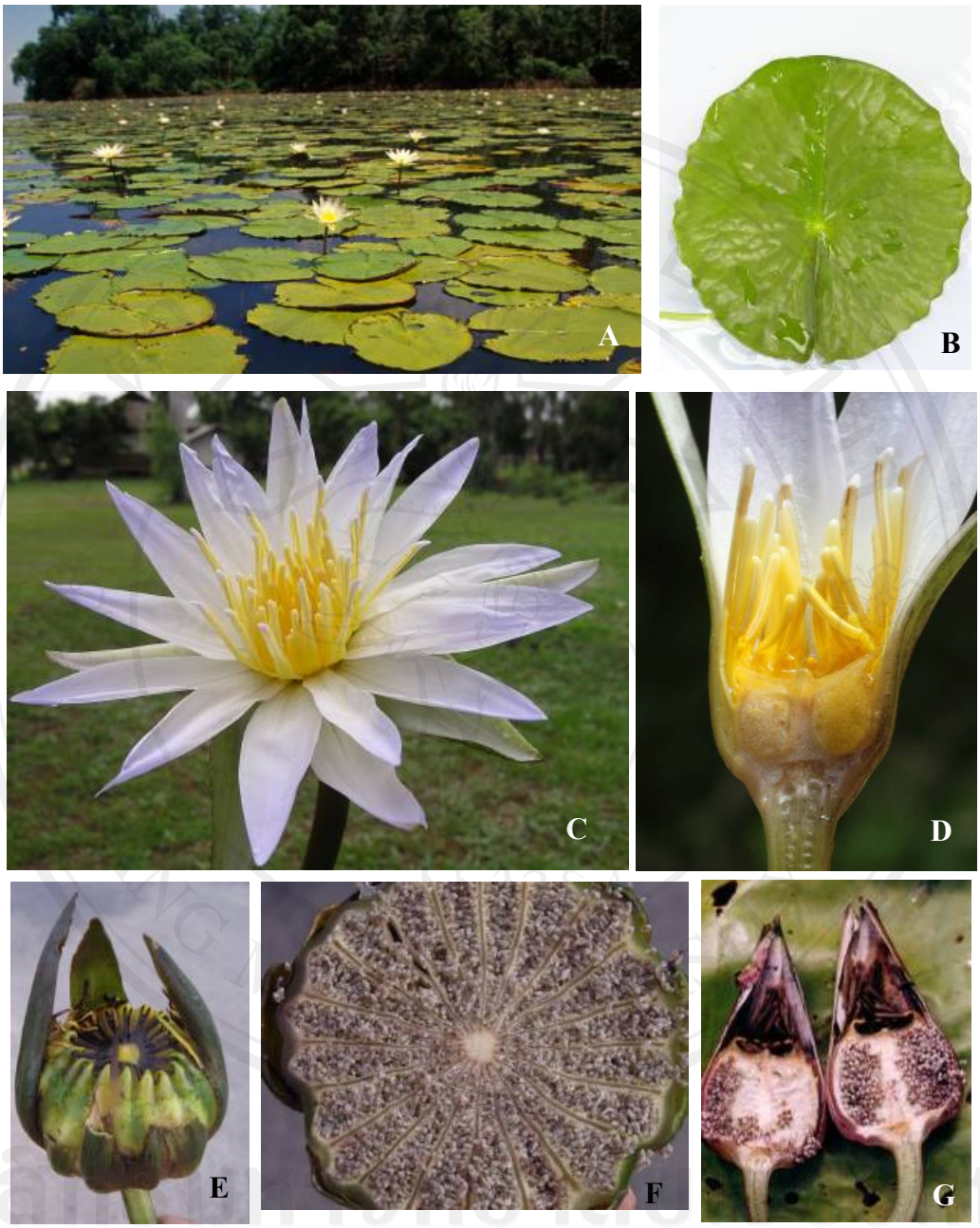

Figure 48. *Nymphaea nouchali* Burm. f.

A. habitat and habit; B. leaf blade, note crenate margin; C. flower; D. flower l.s. showing many stamens, each with sterile dental appendages and triangular-tapered stigmatic appendages; E. fruit. F. Fruit x.s. showing incompletely fused carpels; G. fruit l.s. (photo: W. La-ongsri, A-D, G in Songkhla; H. Balslev E–F in Nakhon Sawan).

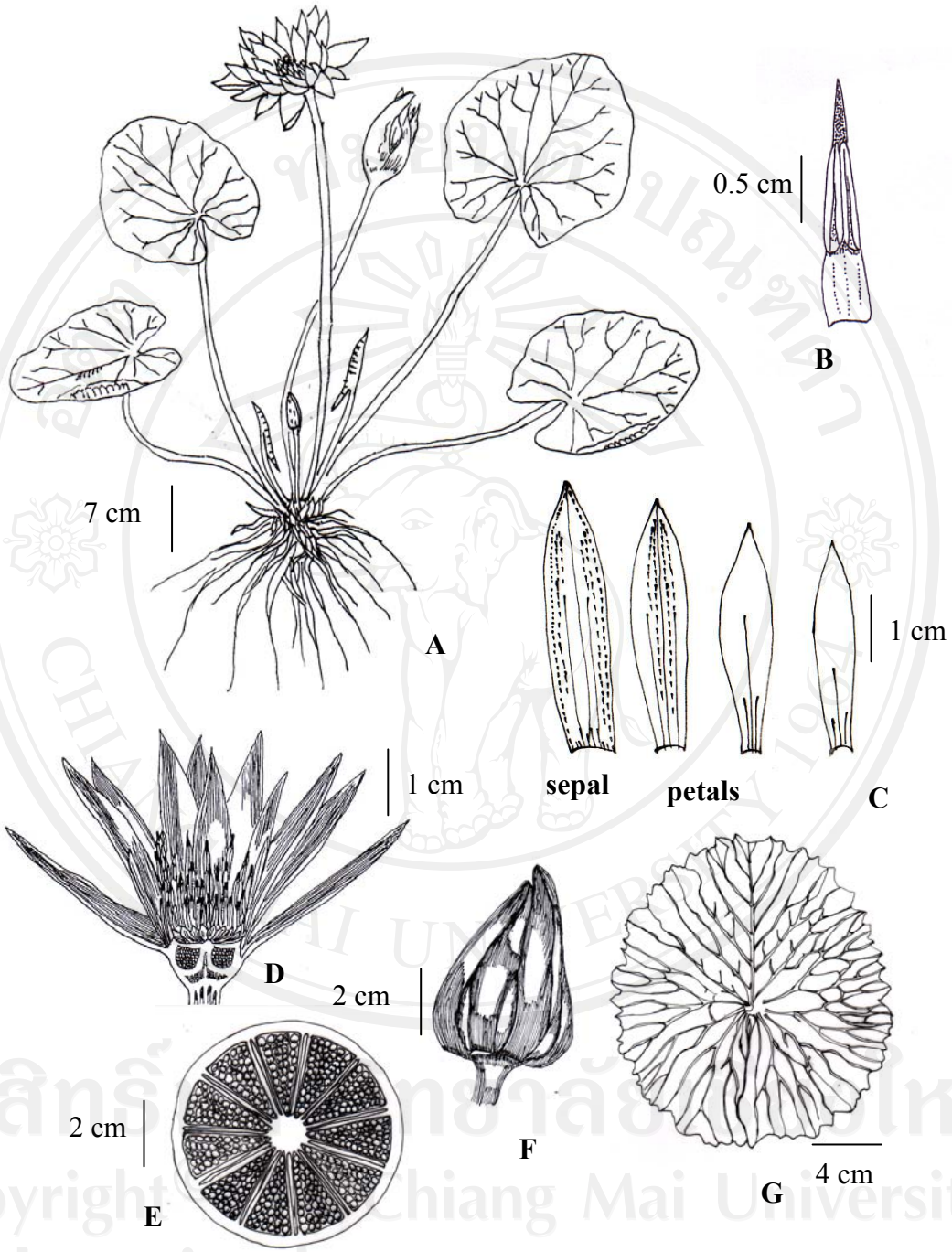

Figure 49. Line drawing of *Nymphaea nouchali* Burm. f.

A. habit, showing leaves and flower; B. stamen; C. sepal and petals shape;

D. flower long-section; E. ovary cross-section; F. fruit; G. leaf.

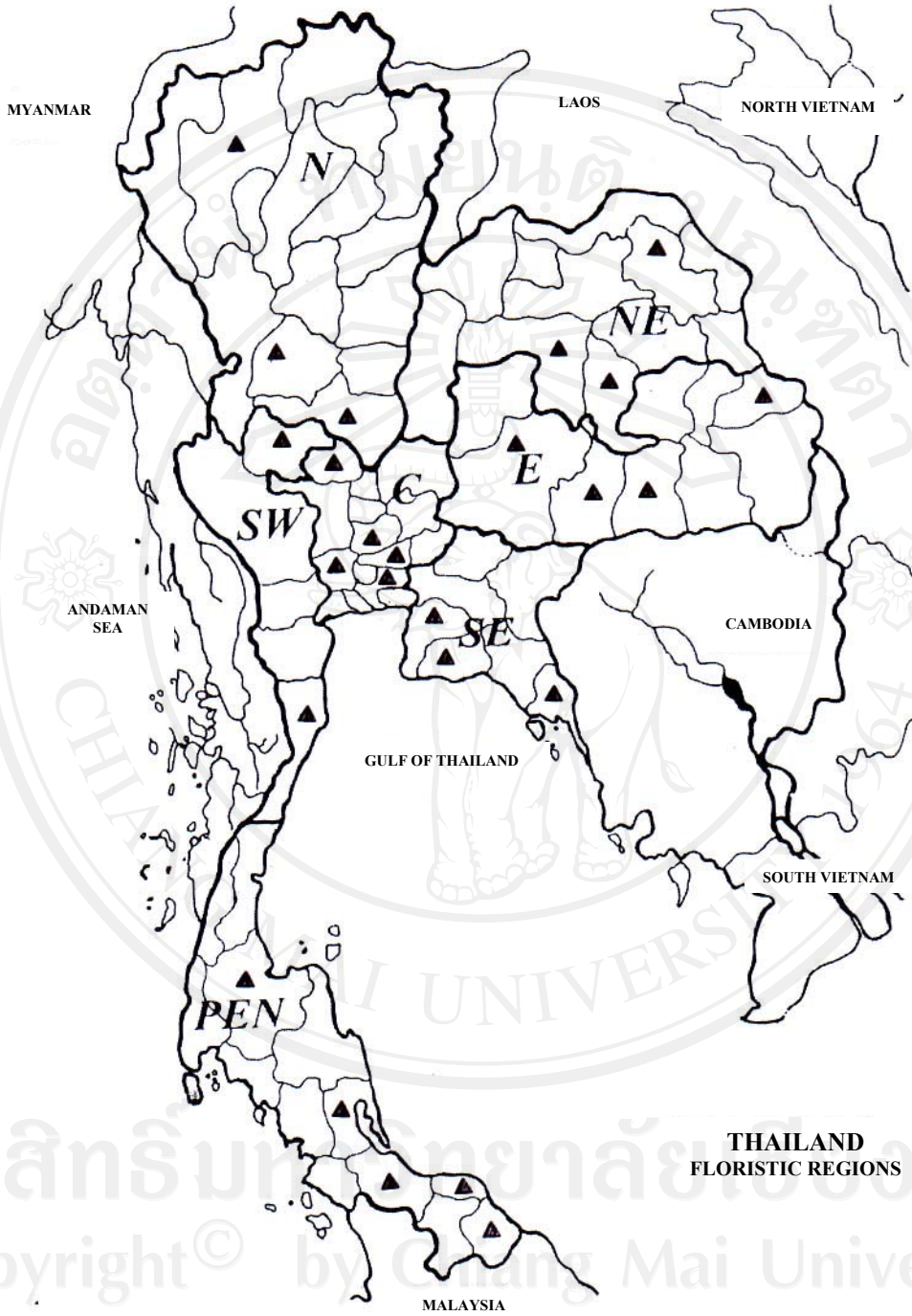

Figure 50. Distribution of *Nymphaea nouchali* Burm. f.

3. *Nymphaea pubescens* Willd.

Nymphaea pubescens Willd., Sp. pl. 2(2): 1154.1799. ― *Nymphaea lotus* γ *pubescens* (Willd.) J.D. Hook. & Thomson, Fl. Ind. 1: 241. 1855. *Castalia pubescens* (Willd.) Woodv. & Wood., *Leuconymphaea lotus* var. *pubescens* (Willd.) Kuntze. Type; India. Herb. Willd. 10100 (B, Microf !).

Nymphaea coteka Roxb. ex Salisb., Ann. Bot. 2: 73. 1806. *pro syn.* ― *Castalia edulis* Salisb., Ann. Bot. 2:73. 1806. ― *Nymphaea edulis* (Salisb.) DC., Syst. Nat. 2: 52. 1821. Type: India. *Roxburgh s.n*. (Salisbury 1806: 73 says "*N. Coteka*. Roxb. MS. Cum Ic, fide cujus proposui"; de Candolle 1821: 52 says "*N. Coteka*. Roxb. mss. cum ic. in bibl. Banks.)

Castalia sacra Salisb., Parad. lond. 1(1): t.14. 1806. ― *Nymphaea esculenta* Roxb., Hort. Beng.. 41, 1814. *nom. nud*. Type: India. Grown in Calcutta Botanical Garden, *Roxburg s.n.*

Nymphaea sagittata Edgew., Trans. Linn. Soc. London 20: 23. 1851. Type: N.W. India. Prov. Sirhind. Ambala. (*M.P. Edgeworth s.n., 1844* K!)

Nymphaea semisterilis Lehm., Hamburger Garten–Blumenzeitung 9: 203, 215. 1853. Type: India. Maradabad, (K n.v.). Lehman 1853: 203 says "Lehm. Icon. Nymph. inedit. (v.s.)", Conard 1905:198 says "fid. Hooker and Thomson 1855, and specimen in hb Kew"

Nymphaea bella Lehmann, Hamburger Garten-Blumenzeitung 9: 198, 212. 1853 *pro parte*. Type. India. *Without collector* (herbarium Lehmann in B, K; Conard 1905:141 says that "the flower is of =*N. stellata* var. *versicolor* which is =*N. nouchali* in this study; Conar 1905: 198 says that the leaf is of *N. pubescens* which=*N. pubescens* in this study.

Nymphaea spontanea K.C. Landon, *nom. nud,* P. D. Slocum and P. Robinson, Water gardening: Water lilies and lotuses 184. 1996, *nom. illegit.*

Leaves broadly ovate to slightly orbicular, 15–50 x 12–45 cm, peltate or subpeltate, dark green above, purplish-green with purple spots beneath, apex round, basal lobes acute or obtuse, above glabrous to finely punctuate, densely grayish, below brownish tomentose (sometime on veins only); *veins* 5–8 pairs, above

inconspicuous, below prominent and angular, midrib priminulous or flat; **margins** dentate, repend to sinuate spinous-dentate somewhat crispate; petioles terete, green or reddish-brown, pubescent. **Stipules** present as a narrow transparent wing on either side of the petiole at the base. **Flowers** 4–15 cm in diam., white. **Sepals** 4, oblanceolate to ovate-lanceolate, 2.5–8.5 x 1–5 cm, obtuse or subacute, green or a part of sepals with tinge of purple toward to outside, below with 5–9 prominent white veins, pubescent or glabrous. **Petals** oblanceolate, 8–30, 2–7 x 1–2.8 cm obtuse or acute, white, a part of outer petals with tinge of red toward the outside. **Stamens** 30–90, inner ones shorter than outer ones, 1.5 –3.5 long, yellow, filaments broadly lanceolate, linear, anther yellow, longer than filament in the inner stamens. **Ovary** 13–21-locular, finely pubescent; stigmatic appendages 13–21, 0.5–1 cm long, linear, obtuse incurved, yellow, axile process elongate, short, apex round, about 2 mm, glabrous. **Fruit** 3-6 cm in diam., globose berry with remnants of stamens at apex. **Seeds** numerous, 1 mm long, ellipsoid, glabrous, with longitudinal rows of irregular papilla (Figures 51-52).

Specimens examined:— NORTHERN: Chiang Mai. Mueang district, Chiang Mai University, 350 m, *Bjørnland and Schumacher No. 429* (BKF, C); Ban Huai Sai 12 km S. of Mae Sariang, 250 m, *K. Larsen, T. Santisuk and E. Warncke 2370* (AAU, BKF, L); Saraphi district, Ban Praya Chom Puu, *W. La-ongsri 303* (QBG). **Lampang. Mae tha district, Nam jang river,** *W. La-ongsri 348* (QBG). **Kamphaeng Phet.** 100 m, *C. Phengklai et al. 3947* (BKF). **Nakhon Sawan.** Bueng Borapet, 9 m, *W. La-ongsri 292* (QBG). **— NORTH-EASTERN: Sakon Nakhon.** Nong Haan pond, c.150 m, *R. Pooma, W. J. J. O de Wild, B. E. E. Duyfjes, V. Chamchumroon, K. Phattarahivankanok 2575* (BKF, GH). **Maha Sarakham.** Kheng Loeng Chan district, Ban Kud Pang, 124 m, *W. La-ongsri 253* (QBG). **Mukdahan.** Water-hollow on the mountain at Phu Saa Dok Bua National Park, 423 m, *W. La-ongsri 256* (QBG). **Nong Khai.** Faw Rai subdistrict, Ban Non Pla Man, Tambon Nong Luang, 145 m, *W. La-ongsri 264* (QBG). **Khon Kaen.** Phon district, Ban Non Hawm, Pek Yai, 174 m, *W. La-ongsri 273* (QBG); Waeng Yai district, Ban Kud Makhep, Non Sa Ard, 198 m, *W. La-ongsri 325* (QBG). **— SOUTH-WESTERN: Uthai Thani.** Nong Kha Yang district Ban Sum Rong, Tambon Nam Song, , *W. La-ongsri 312* (QBG). **Phachuap Khiri Khan.** Khui Buri district, Khao Sam Roi Yot National Park, 5 m, *W. La-ongsri*

337 (QBG). **Phetchaburi.** Cha Um district, Road to Puek Tian beach, *W. La-ongsri 276* (QBG). **— CENTRAL: Bangkok.** Bang Bawn, Tonburi –5 m, *A. F. G. Kerr 9329* (BK, K); Bang Bon near Bangkok, *A. Marcan 1816* (K), Bangkok, *A. F. G. Kerr s.n.* (BK); Bangkok, *A. Marcan 1903* (K); Bangkok, *A. Marcan 480* (K). **Chai Nat.** Wat Sing district, Ban Mai Hua Fai, 40 m, *W. La-ongsri 294* (QBG); Manorom district, Ban Thamma Moon, 85 m, *W. La-ongsri 296* (QBG). **— SOUTH-EASTERN: Rayong.** Naa Yai Aam district, Klong Naam Khem, Ban Nern Tong Chai, sea level, *W. La-ongsri 279* (QBG); Klaeng district, Reservoir at Ban Laem yaaw, sea level, *W. La-ongsri 282* (QBG). **— PENINSULAR: Phatthalung.** Tha Lae Noi Wildlife Sanctuary, Khuankhanoon district, ca 10 m, *T. Shimizo, H. Toyokni, H. Koyama, T. Yahara and T. Santisuk. 27730* (BKF, GH), *W. Laongsri 227* (QBG). **Songkhla.** Ranod district, Ban Pran, Tambon Ta Kaea, sea level, *W. La-ongsri 328* (QBG); Kra Sae Sin district, Laem Kwai Raap, Tha Lae Sab Wildlife Sanctuary, Ban Fai Raap, Tambon Koh Yai, sea level, *W. La-ongsri 232* (QBG). **Satun.** Tha Lae Ban National Park, *W. La-ongsri 246* (QBG). **Thailand**, without locality, *A. F. G. Kerr 9329 Sheet 2* (K).

Distribution: — Throughout Thailand in all regions (Figure 53), Burma, Laos, Cambodia, Vietnam, Malaysia, Philippines, Indonesia, New Guinea, Sri Lanka and India

Vernacular: **—** Bua kin sai (บัวกินสาย), Bua khom (บัวขม), Bua khi phae (บัวขี้แพะ)

Uses: — Young peduncles are eaten as vegetables.

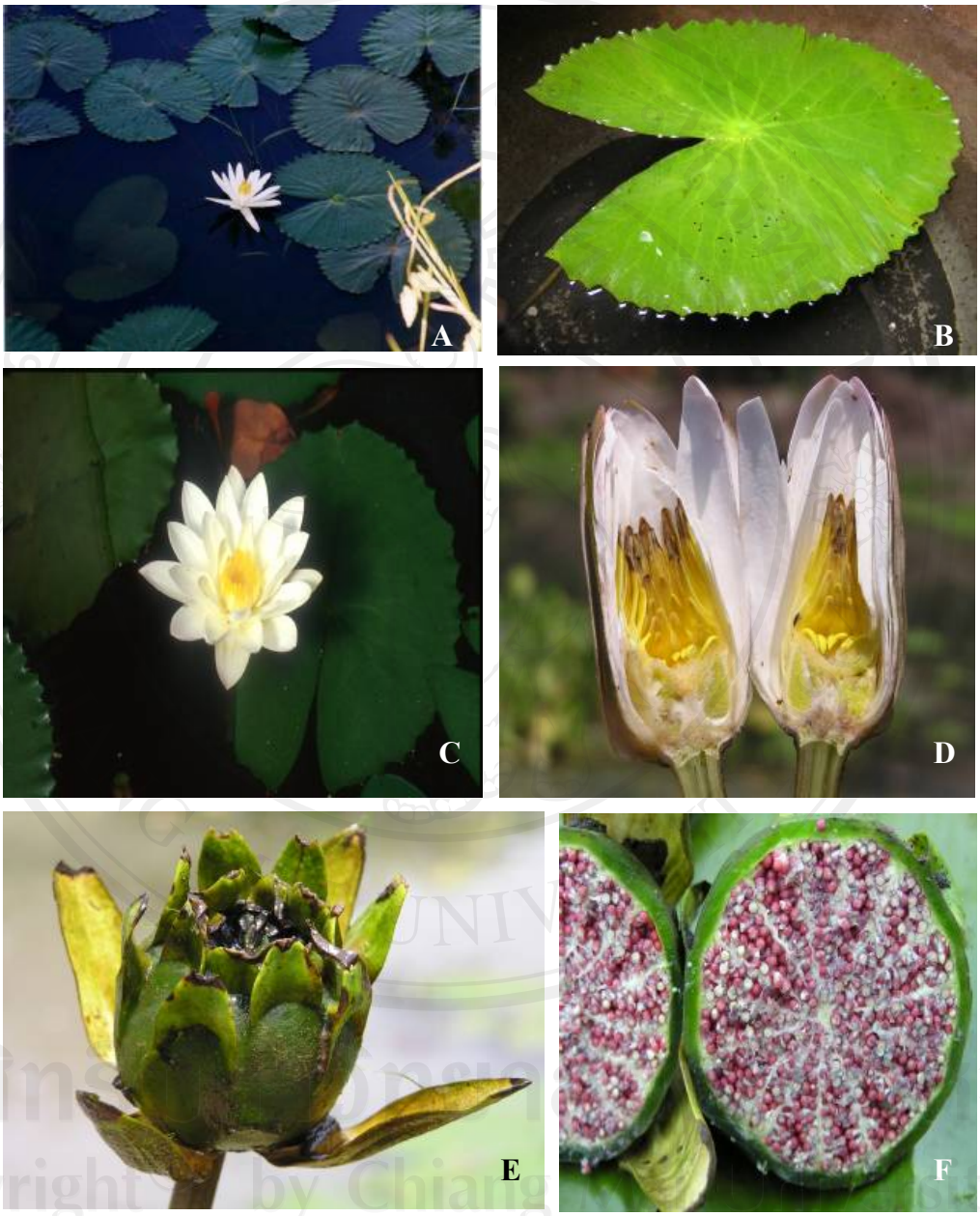

Figure 51. *Nymphaea pubescens* Willd.

A. habitat and habit; B. leaf blade, note ovate outline and dentate margin; C. flower; D. flower l.s. showing long, linear stigmatic appendages, note lacking dental appendages on stamens; E. fruit; F. fruit x.s. showing completely fused carpels (photo: W. La-ongsri, A-F, in Chiang Mai and Prachuap Khiri Khan).

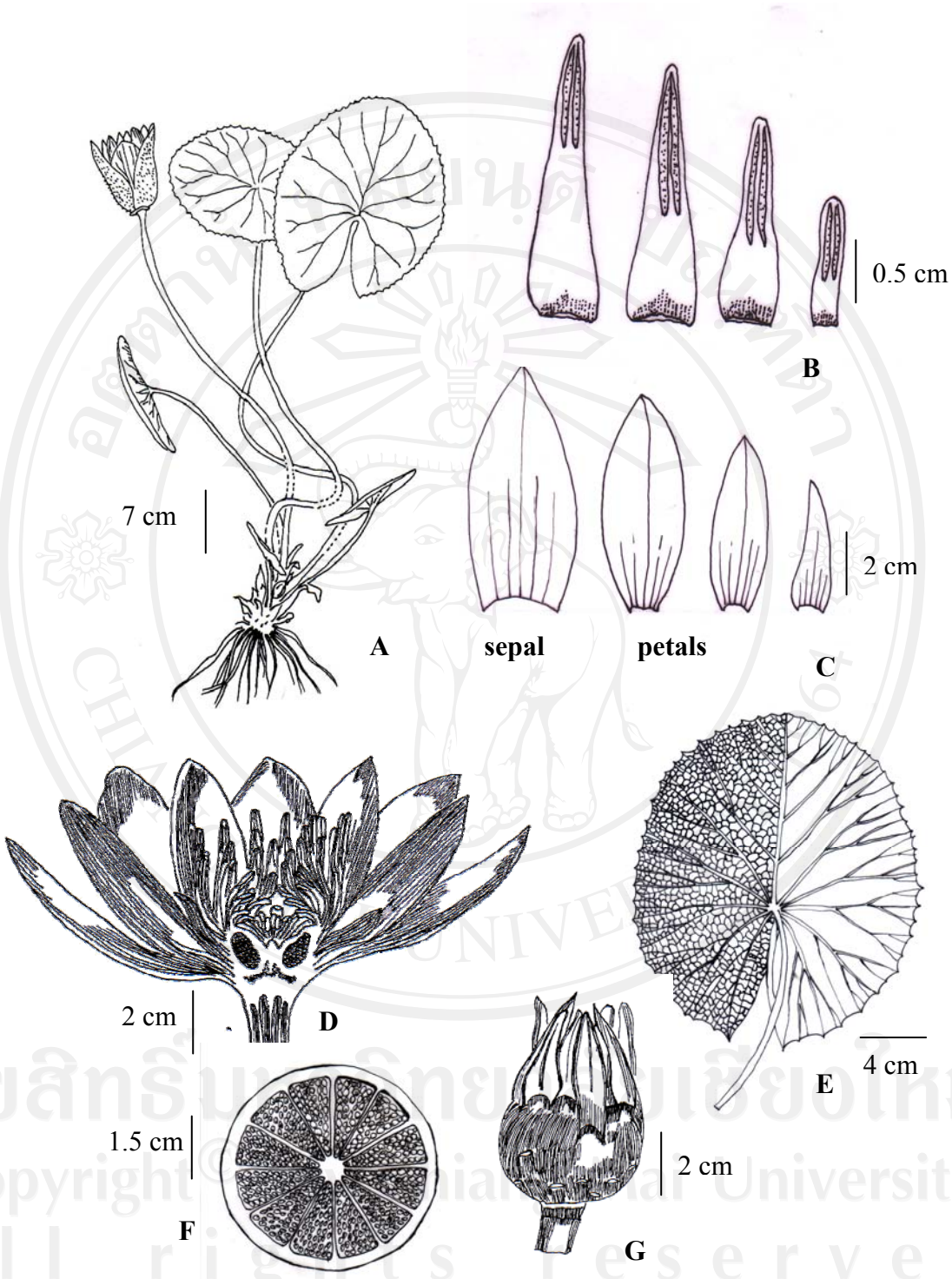

Figure 52. Line drawing of *Nymphaea pubescens* Willd.

A. habit, showing leaves and flower; B. stamen; C. sepal and petals shape; D. flower long-section; E. leaf; F.ovary cross-section; G fruit.

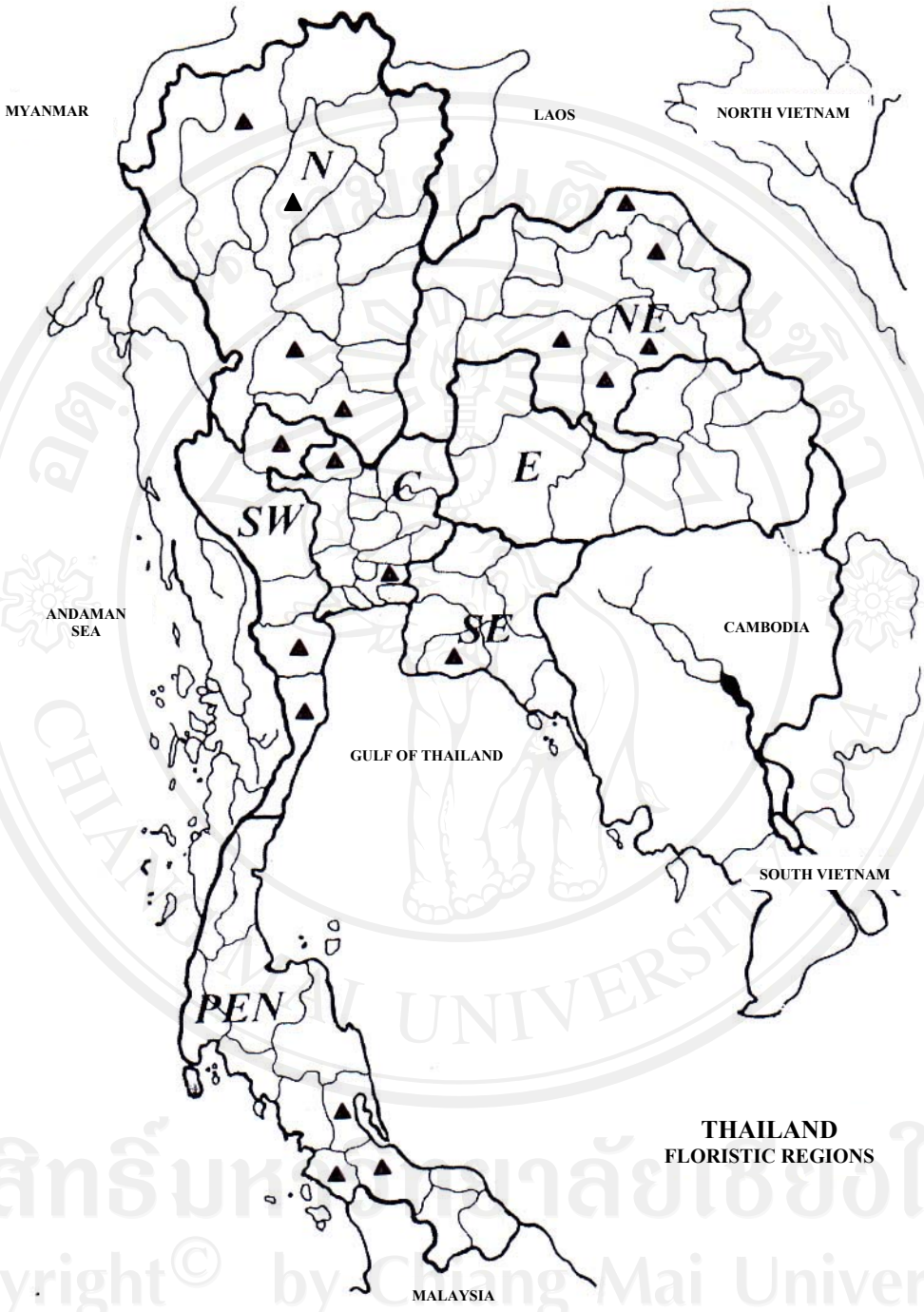

Figure 53. Distribution of *Nymphaea pubescens* Willd.

4. *Nymphaea rubra* Roxb. ex Salisb.

Nymphaea rubra Roxb. ex Salisb., Parad. lond I. t 14. 1806. pro syn. ― *Nymphaea rubra* Roxb. ex Andr., Bot. repos. 8(104):t. 503. 1808. *Leuconymphae rubra* (Roxb. ex Andrews) Kuntze. Type: "Sponte nascentem in Hindustan, paludibus, legit G. Roxburgh.", Andrews, Bot. Rep. t. 503

Castalia magnifica Salisb., Parad. lond. 1. t. 14. 1806. ― *Nymphaea magnifica* (Salisb.) Conard, Rhodora 18:120. 1916. Type: Parad, Lond. 1 t. 14.

Nymphaea (hybrida) devoniensis Hook., Bot. Mag. 8: t. 4665. 1852. ― *Nymphaea rubra* Roxb. var. *devoniensis* (Hook.) F. Henkel, F. Rehneli and L. Diltman, Das Buch der Nymphaeaceen oder Seerosengewächse: 72. 1907. Type: Bot. Mag. 8: t. 4665

Nymphaea rubra (β) rosea Sims, Bot. Mag. 33: t. 1364. 1811. ― *Nymphaea rosea* (Sims) Sweet, Hort brit. Ed. 2: 17. 1830. Type: E. India: Bot. Mag.33. t 1364.

Nymphaea rubra Roxb. var. *columbiana* F. Henkel, F. Rehneli and L.Diltman, Das Buch der Nymphaeaceen oder Seerosengewachse: 72. 1907. Type: based on living plant in Kew 1901.

Nymphaea rubra Roxb. var. *krumbiegelii* F. Henkel in F. Henkel, F. Rehneli and L. Diltman, Das Buch der Nymphaeaceen oder Seerosengewachse 72. 1907. Type: East India. *Krunbiegel s.n.* (K) hort. Henkel.

Nymphaea lotus sensu Hook. f. & Thomson, Fl. Ind. 1: 241. 1855 & in Hook. f., Fl. Brit. India 1: 114. 1872, non L. 1753, uterque p.p. quoad syn. *N. rubra*.

Leaves 20–45 cm across, peltate, orbicular, dark-reddish both above and below, becoming greenish above with age, below pubescent; *veins* about 9 pairs, midrib flat above, prominent and angular below; margin subspinose-dentate and more or less wavy, teeth sharp; petioles terete, green or reddish-brown, pubescent; stipules present as a narrow transparent wing on either side of the petiole at the base. **Flowers** 15–20 cm in diam., deep red. **Sepals** four, oblong to lanceolate, dull purplish-red, about 7-nerved. **Petals** 16–25, elliptic to oblanceolate, deep red. **Stamens** 55–96, 3–5 cm long, orange or cinnabar-red, becoming brownish, filaments broadly lanceolate, nearly linear, anther orange. **Ovary** 16–21-locular, stigmatic appendages 16–21, 1 cm long, linear incurved, orange, axile process elongate, 1–2 mm. **Fruit** 3-6 cm in

diam., globose berry with remnants of stamens at apex. **Seed** 1.8–1.6 mm, ellipsoid to globose (Figures 54-55).

Specimens examined:— NORTHERN: Chiang rai. Nong Luang, 397m, *W. La-ongsri 318* (QBG). **Chiang Mai.** Mueang district, 350 m, *Bjørnland and Schumacher 437* (BKF, C); Suan Dok, *Nai Noi Maw s.n.* (BK); San Kham Phaeng district, Tambon Orn Tai, Ban Pha Phaw Ngam, 170 m, *W. La-ongsri 250* (QBG). **Payao.** Kwan Payao, 394 m, *W. La-ongsri 298* (QBG). **Nan.** Mueang district, Tambon Bo, Ban pha hang, *W. La-ongsri 344* (QBG); Weang Sa district, Ban mae sakhon, *W. La-ongsri 346* (QBG). **Lampang.** Mae tha district, Tambon Don fai, Ban dong pae mai, *W. La-ongsri 347* (QBG); Hang chat district, Nong kham, *W. La-ongsri 352* (QBG) **Nakhon Sawan.** Bueng Borapet, 9 m, *W. La-ongsri 288, 289* (QBG). **— NORTH-EASTERN: Kalasin.** Ban Daan Suan, Tambon Nay Mueang, on outskirts of a Muang Kalasin, ca 150 m, *M. Widmer. 0080* (BKF). **Maha Sarakham.** Kud Rung subdistrict, Ban Pai San, Na Po, 170 m, *W. La-ongsri 252* (QBG). **Sakon Nakhon.** Nong Haan, 299 m, *W. La-ongsri 257* (QBG). **Khon Kaen.** Phon district, ca 150 m, *W. La-ongsri 251* (QBG). **Nong Khai.** Se ka district, Bueng Khong Long Wildlife Sanctuary, Nong Pai Naa, Tambon Ban Tong, 174 m, *W. La-ongsri 261*(QBG); Huai Chorakhae Maak Reservoir, 156 m, *W. La-ongsri 319* (QBG). **— EASTERN: Nakhon Ratchasima.** Pra Tai district, Ban Nong Saad, *W. La-ongsri 266* (QBG). **Buri Ram.** Lam Pray Maas district, Kok Laam Reservoir, Ban Kok Laam, 175 m, *W. La-ongsri 268* (QBG); Mueang district, Huai Talad Reservoir, Huai Talad Non-Hunting Area, km 13 the way to Pra Kon Chai district, 167 m, *W. La-ongsri 271* (QBG). **— SOUTH-WESTERN: Ratchaburi.** Mueang district, Ban Ku Bua, Tambon Ku Bua, 10 m, *W. La-ongsri 306* (QBG). **Phachuap Khiri Khan.** Khui Buri district, Khao Sam Roi Yot National Park, 5 m, *W. La-ongsri 222, 338* (QBG). **— CENTRAL: Bangkok.** *A. F. G. Kerr s.n.* (BK); Bangkok under 5 m, *A. F. G.Kerr 4388* (K). **— SOUTH-EASTERN: Rayong.** Klong Naam Khem, Ban Nern Tong Chai, Naa Yai Aam, sea level, *W. La-ongsri 278* (QBG); Klaeng district, Ban Pak Dong, M.1 Saak Pong, sea level, *W. La-ongsri 286* (QBG). **— PENINSULAR: Phatthalung.** Kuankhanoon district Tha Lae Noi, Non-hunting area, , ca 10 m, *T. Shimizu, H. Toyakuni, H. Koyama, T. Yahara and T. Santisuk 19831* (BKF), *W. La-ongsri 226, 328, 332* (QBG). **Songkhla.** Ban Naam Noi, by railway, ca 50 m, *W. La-*

ongsri 230 (QBG); Ranood district, Ban Pran, Tambon Ta Kaea, *W. La-ongsri 328* (QBG); Kra Sae Sin district, Laem Kwai Raap, Tha Lae Sab Wildlife Sanctuary, Ban Fai Raap, Tambon Koh Yai, sea level, *W. La-ongsri 234* (QBG).

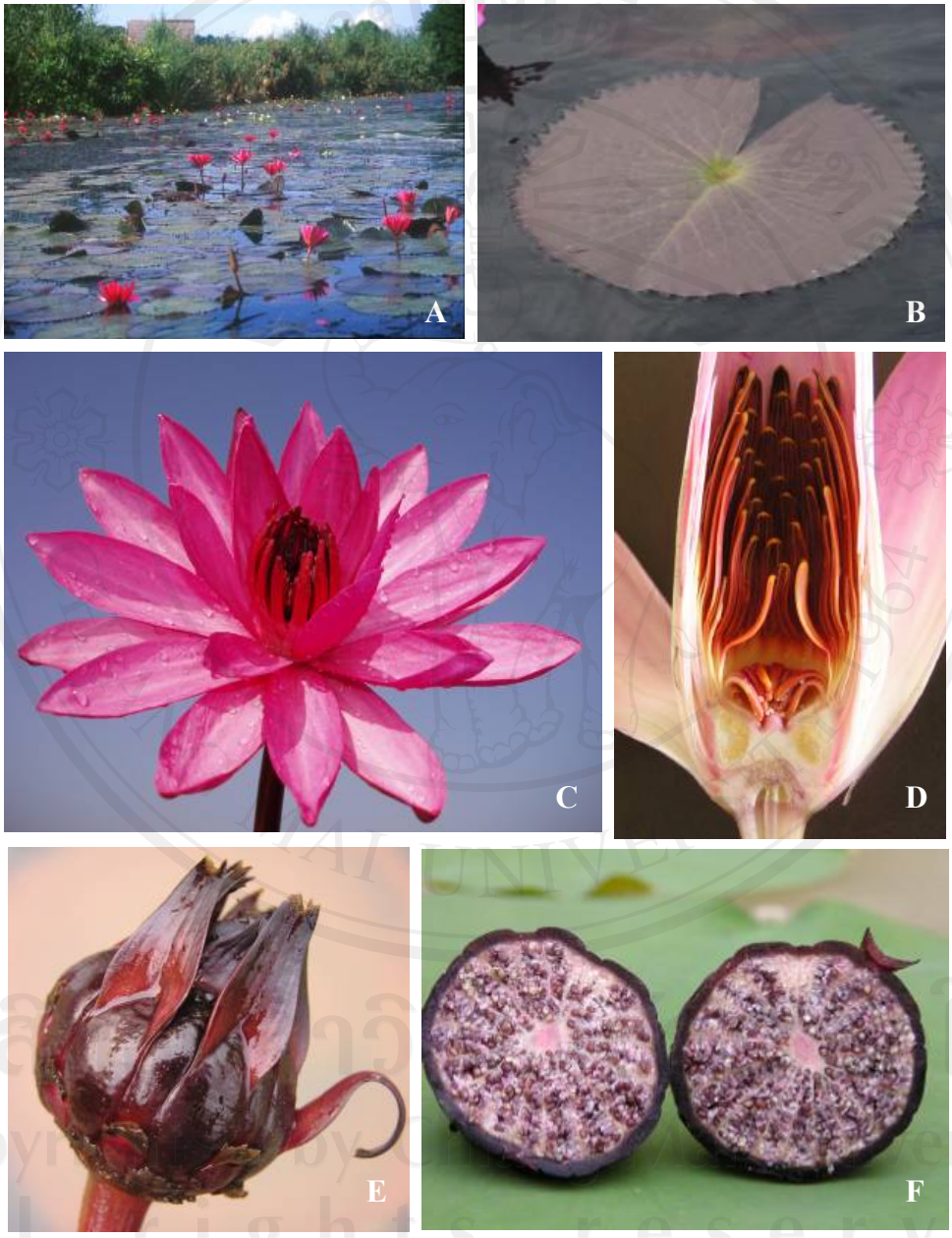

Figure 54. *Nymphaea rubra* Roxb. ex Salisb.

A. habitat and habit; B. Leaf blade, note obicular outline and dentate margin; C. flower; D. flower l.s., showing long, linear stigmatic appendages, note lacking dental appendages on stamens; E. fruit; F. fruit x.s. showing completely fused carpels (photo: W. La-ongsri, A-B, D–F in Songkhla; H. Balslev C in Sakon Nahon).

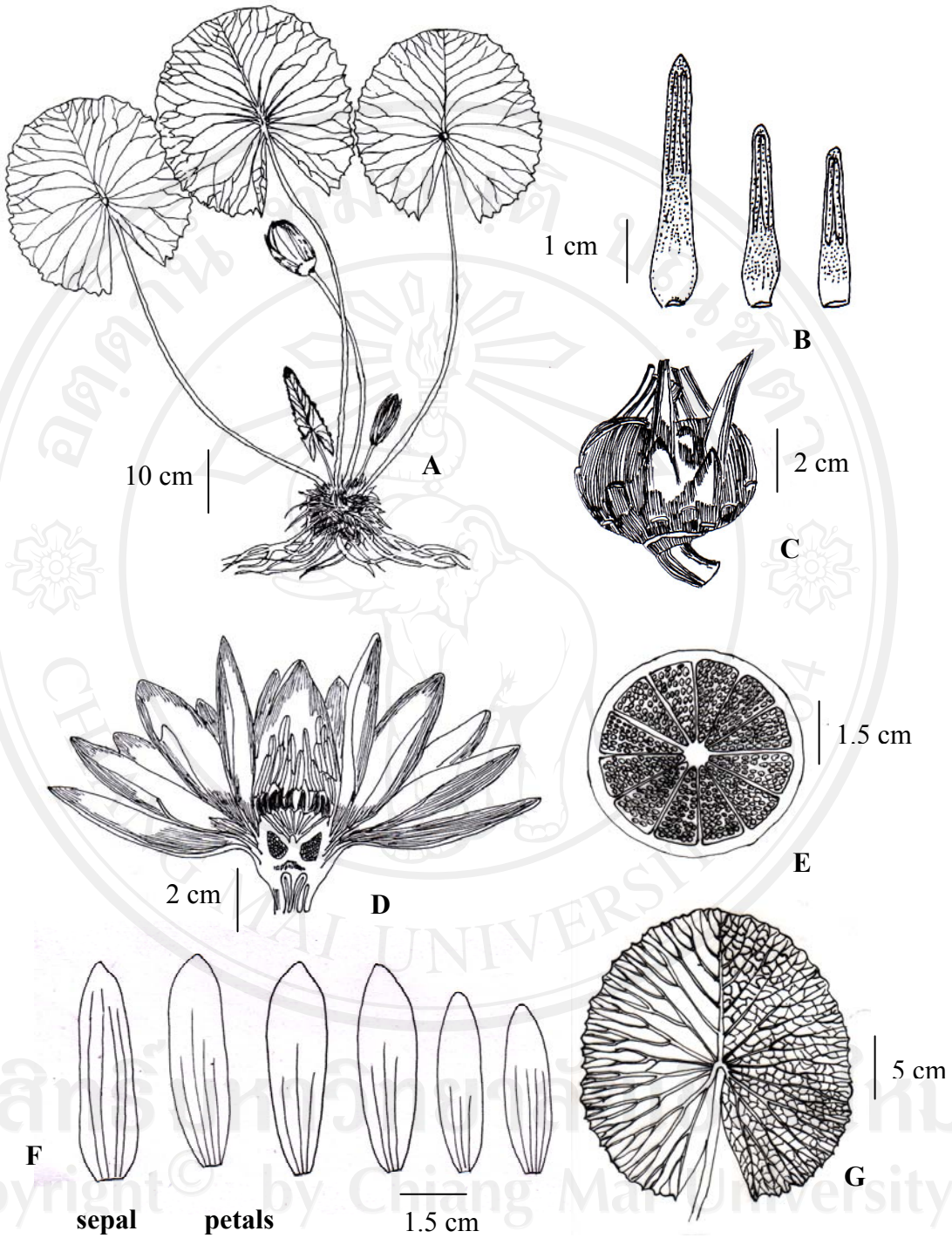

Figure 55. Line drawing of *Nymphaea rubra* Raxb. ex Salisb.
A. habit, showing leaves and flower; B. stamen; C. sepal and petals shape; D. flower long-section; E. ovary cross-section; F. sepal and petals; G. leaf.

Distribution: — Throughout Thailand in all regions (Figure 56), Burma, Laos, Cambodia, Vietnam, Malaysia, Indonesia, Philippines, Sri Lanka, and India.

Vernacular: **—** Bua daeng (บัวแดง), Bua sai daeng (บัวสายแดง), Pan daeng (ป้านแดง), Sattaban (สัตตบรรณ)

Uses: — The young peduncles are eaten as a vegetable. In India the fried seeds are eaten as puffed grain.

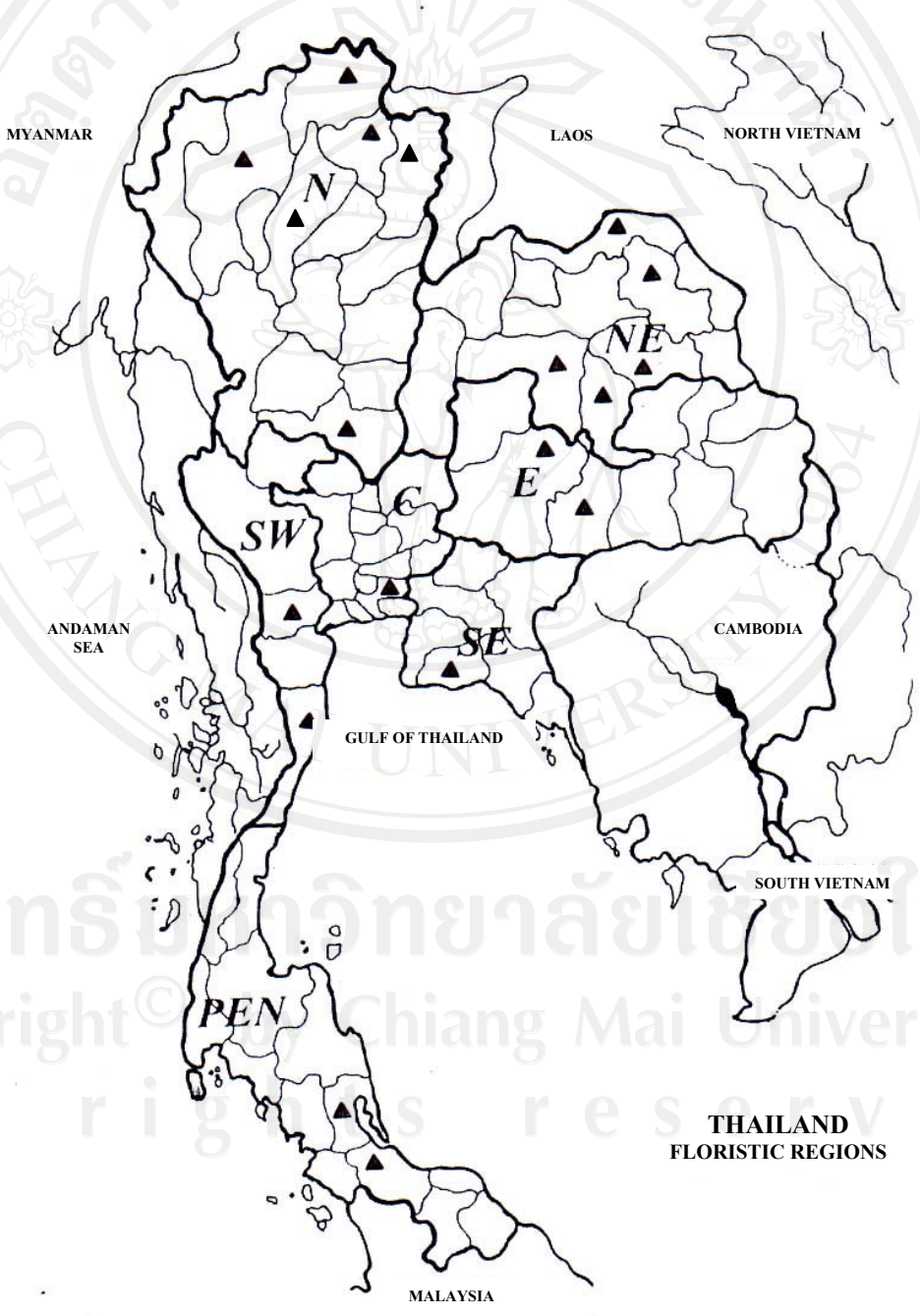

Figure 56. Distribution of *Nymphaea rubra* Roxb. ex Salisb.

Uncertain names

Nymphaea rhodantha Lehmann, Hamburger Garten-Blumenzeitung 9: 198, 214. 1853. Type. Philippines. *Cumming 702* (B, =*N. stellata* var. *versicolor* in Conard 1905: 141, which is =*N. nouchali* in this study).

CULTIVATED SPECIES

A few species of introduced Nymphaeaceae are cultivated and grown as ornamentals in Thailand as follows:

Key to the species of Nymphaeaceae cultivated in Thailand

1. Day blooming
   2. Flowers blue, 15–25 cm in diam. when fully open; petals 16–30, deep purple (light blue or rosy in some varieties); stamens 126–275. Leaves nearly orbicular or ovate, green with purple at margin and purple spots beneath. **1. *Nymphaea capensis var. zanzibariensis***
   2. Flower pink, perianth numerous, sterile flower **2. *Nymphaea* 'Jonkolnee'**
1. Night bloomning
   3. Flower white, 12-15 cm in diam., leaf orbicular, margin dentate **3. *Nymphaea lotus***
   3. Flower creamy white to dull crimson; stamens numerous, without appendages, leaf upturned at margins **4. *Victoria amazonica***

1. *Nymphaea capensis* var. *zanzibarensis* (Casp.) Conard

***Nymphaea capensis* var. *zanzibarensis* (Casp.) Conard,** Waterlilies: 157. 1905.- Basionym: *Nymphaea zanzibariensis* Casp., Bot. Zeitung (Berlin) 35: 203. 1877. — *Nymphaea stellata* var. *zanzibariensis* (Casp.) Hook. f. Bot. Mag. 111: t. 6843. 1885. — *Leuconymphaea sansebariensis* (Casp.) Kuntze, Revis. gen. pl. 1: 11. 1891. — *Castalia zanzibarensis* (Casp.) Britton, Fl. Bermuda: 135. 1918. — *Nymphaea caerulea* subsp. *zanzibariensis* (Casp.) S. W. L.

Jacobs, Telopea, 5(4): 705. 1994. — *Nymphaea nouchali* var. *zanzibariensis* (Casp.) Verdc., Fl. Trop. E. Afr., Nymphaeaceae 10. 1989. Type: specimens cultivated at Konigsberg from seed sent from Zanzibar by *Hildebrandt [no. 901]* (B, syn., K, M. isosyn.): *Caspary s.n.* (holotype B Destroyed; isotype:K)

Nymphaea colorata Peter, Abh. Kőnigl. Ges. Wiss. Gőttingen Math.–Phys. Kl. Ser. 2, 13(2): 58, 68, fig.10, t. 16A. 1928. Type; Tanzania, Tanga District, Amboni–Mobokweni, *Peter 24801 and* Uzarano, near Soya (?Soga), *Peter 44716* and Dar es Salaam–Mabokweni, *Peter 44797* (syntype B!) – the other syntype from S. Peres, Mkomazi–Mkumbara, *Peter 10816* (B!) is closer to var. *caerulea*

Nymphaea colorata Peter var. *parviforea* Peter, Abh. Kőnigl. Ges. Wiss. Gőttingen Math.–Phys. Kl. Ser. 2, 13(2): 58, 70. 1928. Type: Tanzania, Uzaromo District, Dar es Salaam, Lake Mbagala [mabagara], *Peter 45086* (holotype B!,) – links with *N. sphaeantha*.

Nymphaea pupurascens Peter, Abh. Kőnigl. Ges. Wiss. Gőttingen Math.–Phys. Kl. Ser. 2, 13(2): 59, 73. 1928. Type: Tanzania, Uzaromo District, Dar es Salaam to Magineni, *Peter 44586* and Dar es Salaam, Lake buharati [Ununyo] Pool, *Peter 44873* (syntype B!).

Nymphaea zanzibariensis var *pallida* Peter, Abh. Kőnigl. Ges. Wiss. Gőttingen Math.– Phys. Kl. Ser. 2, 13(2): 58, 73. 1928. Type: Tanzania. Lushoto District, near Mhonazi Lake Manka, A. *Peter No. 41076*, Holotype. K (holotype B!)

Nymphaea grandiflora Peter, Abh. Kőnigl. Ges. Wiss. Gőttingen Math.–Phys. Kl. Ser. 2, 13(2): 59, 74, fig. 12, t.18. 1928. Type: Tanzania, near Des es Salaam, Lake [Magogoni] Magagoni, *Peter 44981* (syntype B!).

Leaves 15–60 cm across, somewhat peltate, nearly orbicular or ovate, green above, green with purple at margin and purples spots beneath; veins 9–14 pairs, midrib flat above, prominent below; margin closely and irregularly sinuate-dentate; petiole terete, dark green, about 1 cm in diam.; stipules present as a narrow transparent wing on either side of the petiole at the base. **Flower** 15–25 cm in diam. **Sepals** four, 1.5–2 x 5–9 cm, oblong-ovate, obtuse, below dark green often shaded reddish-brown in distal three quarters, uncovered margin deep carmine-brown, covered margin shading from carmine-brown to deep violet, above deep purplish-

blue, shading to yellowish-green at base, with 5–7 veins. **Petals** 16–30, oblong, long obovate, the outer ones obtuse, the innermost acute, deep purple (light blue or rosy in some varieties). Stamens 126–275 according to size of flower, slightly shorter than the petals, appendages and inner side of the outer anthers deep blue, back of outer anther deep blue, shading to carmine-purple, filament light yellow, long elliptic inner filaments inverted wedge shaped. **Ovary** 15–31-locular, stigmatic appendages 15–31, oblong incurved, glabrous, axile process elongate up to 15 mm, glabrous. **Fruit** yellowish, depressed-spherical, 5.6–6.7 cm, covered by the enlarged, thick and leathery sepals, containing several thousand seeds. **Seeds** brown, ellipsoid, papillate at one end (Figure 57).

Specimens examined:

NORTHERN: Chiang Mai. San Pha Tong district, Tambon Ban Kad, ca 150 m, *W. La-ongsri 340* (QBG). **NORTH-EASTERN: Udon Thani.** Mueang district, 193 m, *W. La-ongsri 265* (QBG). **SOUTH-EASTERN: Chantaburi.** Klung district, Klong aee ngaew, Ban Nong ra haan, *W. La-ongsri 280* (QBG). **Rayong**. Klaeng district, Ban Nong Bua, *W. La-ongsri 283* (QBG). Klaeng district, Ban Pong Sawai, ca. 10 m, *W. La-ongsri 284* (QBG). **PENINSULAR: Songkhla.** In front of the Development of land office, Songkhla, *W. La-ongsri 235* (QBG). **Narathiwat.** Klai ban reservoir, Pi khul Tong, *W. La-ongsri 236, 237* (QBG).

Distribution: Often escaped and adventive in Thailand. Ocurring naturally in the island and town of Zanzibar, Kenya, Tanzania, South Africa.

Vernacular: Sutha sinobon (สุธาสิโนบล)

Uses: As ornamental plant. In some areas in peninsular Thailand the young peduncles are eaten as a vegetable and the seeds are eaten raw.

Notes: The flowers of this species are highly fragrant.

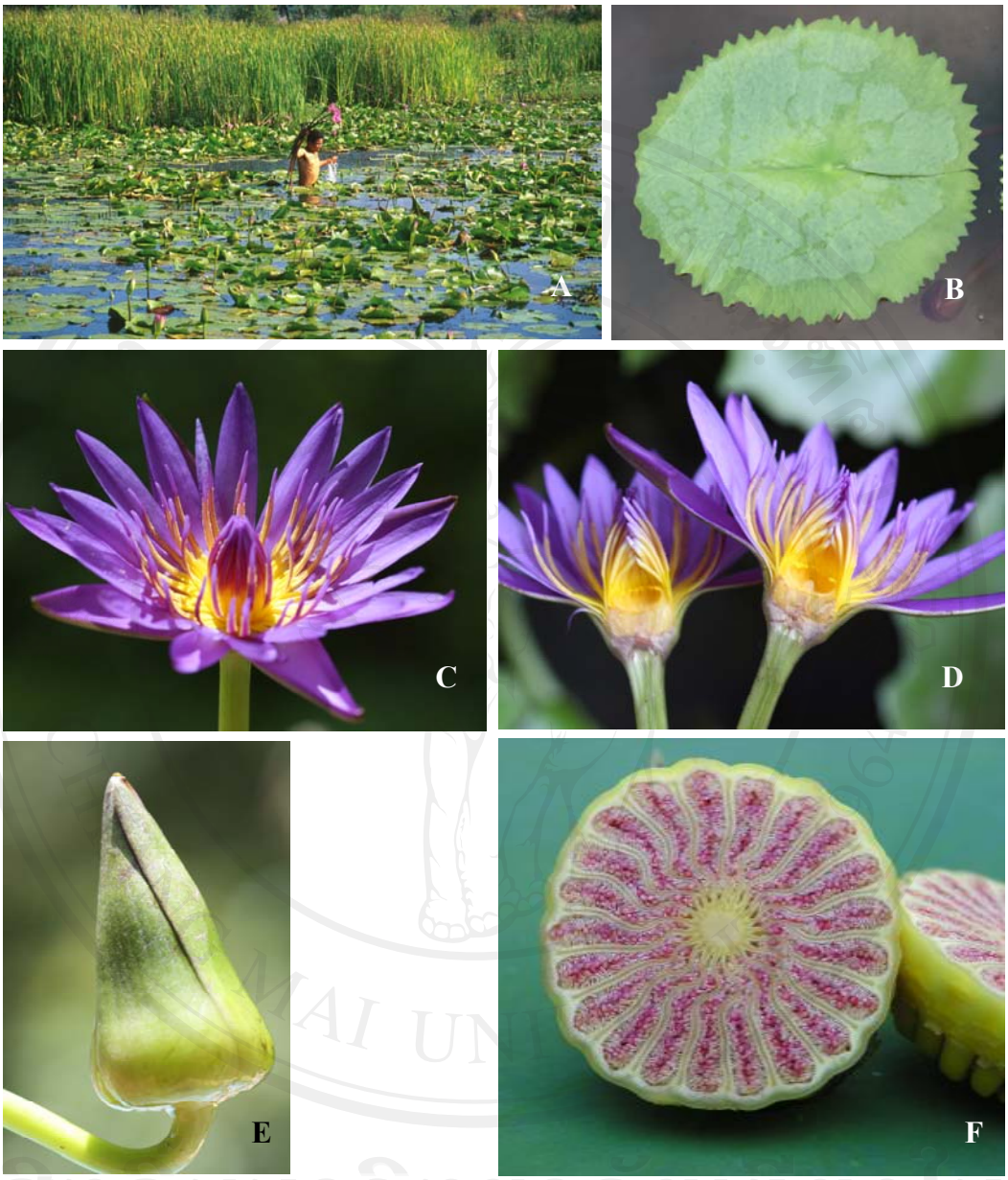

Figure 57. *Nymphaea capensis* var. *zanzibariensis* (Casp.) Conard
A. habit, showing floating leaves and emergent flower; B. leaf blade; C. flower; D. flower l.s., note many stamens, each with a dental sterile appendage; E. fruit; F. fruit x.s. showing completely fused carpels.

***2. Nymphaea* sp. in observation 'Jongkolnee'**

Leaves elliptic to ovate, apex rounded or retuse, glabrous, veins 5–7 pairs, midrib flat above, prominent below, reddish-purple with brown spot beneath; margin crenate or repand, glabrous, petiole terete, brown, glabrous; stipules present as narrow transpatent wing on either side of the petiole at the base. **Flowers** are fully double **Petals** pale pink or white with pink on the tips, becoming white with traces of green on the last day of blooming (Figure 58).

Specimens examined: — CENTRAL: Bangkok. Cultivated, *A. Marcan s.n.* (K)

Distribution: — Cultivated in Thailand
Vernacular: — Chong konni (จงกลนี)
Uses: — Cultivated for ornamental purpose.
Note: — Its extraordinary number of petals and abortive sexual organs are similar to some lotuses. The flower usually blooms for five days. The flower closes or partially closes late in the evening only on the first day. From the second day onward it remains open until it fades. It has only sterile flowers and produces small tubers and its leaves are crenate like other species in the subgenus *Brachyceras*. May be it is a mutation of *Nymphaea nouchali*. It grows best in large ponds outdoors where it requires full sun for at least 4–6 hours per day.

Fiture 58. *Nymphaea* 'Jongkolnee'.
A. flower; B. flower long section.

***3. Nymphaea lotus* L.**

Nymphaea lotus L. Sp. Pl. 1: 511. 1753. — *Castalia lotus* (L.) Woodville & Wood, A. rees, Cycl. 6: Castalia no. 3 1819, in Flora, V. 598. 1822. — *Leuconymphaea lotus* (L.) Kuntze, Revisio generum platarum, Pars 1: 5 Nov. 1891: 11-12. — *Nymphaea aegyptiaca* Opiz, Naturalientausch. X. 216. 1825. nom. illegit. — *Nymphaea lotus* var. *aegyptia* Planch., Ann. Sci. Nat. Bot, Ser. 3. 19: 33. 1853, nom. illeg. Type: Egypt, R. Nile near Cairo, Prospero Alpino, De Plantis Exoitcis, illustration of Lotus aegyptia on P. 213 (1627), drawn from specimens sent by M. Carbonus (lectotype P)

Nymphaea dentata Schumach. & Thonn., Beskrivelse af Guineeiske Planter. 249. 1829. — *Nymphaea lotus* var. *dentata* (Schumach. & Thonn.) G. Nicholson, III. Dict. Gard. 2: 460. 1884-1887. — *Nymphaea lotus* var. *grandiflora* F. Kenkel et al., Das Buch der Nymphaeaceen oder Seerosengewachse 69. 1907, *nom illeg.* Type: *Schum s.n*. (B)

Castalia mystica Salisb., Ann. Bot (Konig & Sims) 2: 73. Jun 1805, (Parad. Lond. 1(1): sub. 14. 1805. — *Nymphaea thermalis* DC., Syst. Nat. 2: 54. 1821. — *Nymphaea lotus f. thermalis (*DC.) Tuzson, Math, Termeszwttud ertesito 25(4): 32-36. 1907. — *Castalia thermalis* (DC.) Simonkai, in Magyar Bot. Lap. VII. 131. 1908. Type: Roumania, near Oradea [Varadino], Petea [pecze] stream, *Kitaibel s.n*. 1845 (holotype, G)

Nymphaea ortgiesiana Planch., Fl. Des. Serres, VII. 68. 1852-53. —*Nymphaea lotus* var. *ortgiesiana* (Planch.) Planch., Ann. Sci. Nat. Bot. Ser. 3. 19: 33. 1853. Type: Planchon Feb. 4 1853 (K)

Nymphaea acutidens Peter, Abh. Ges. Wiss. Gottingen, n. f. XIII. II. 60. 1928. Type: Tanzania, Lushoto District, Lwengera [Luengera] valley, bombo hill. *Peter* 18559 sheet I (lectotype, B!)

Nymphaea hypotricha Peter, Abh. Ges. Wiss. Gottingen, n. f. XIII. II. 60, 78. 1928. Type: Tanzania. Lushoto District, between Mkonazi and Mkumbara, *Peter 10797* (holotype, B!)

Nymphaea lotus L. var. *parviflora* Peter, Abh. Ges. Wiss. Gottingen, n. f. XIII. II. 60. 1928. Type; not indicated but following so-labelled-Tanzania, Uzaramo District, Soga *Peter 44717a* (holotype, B!)

Nymphaea leucantha Peter. Abh. Ges. Wiss. Gottingen, n. f. XIII. II. 60. 1928. Type: Tanzania, Lushoto District, near Mkomazi, Lake Manka, *Peter 41075* (holotype, B!)

Nymphaea reichardiana F. Hoffm. Beitrage zur Kenntnis der Flora von Central-Ost-Afrika 7. 1889. Type: Tanzania, Tabora district, Ugalla R. at Ugolla, *Bohm 92b* (lectotype, B!)(leaf)

Nympahea zenkeri Gilg., in Conard, *Mo*nog. Nymphaea, 197, in Gartenfl. 519. 1906. Type: Cameroon: 07. 1899, *G. A. Zenker 2130* (B!)

Leaves 20–50 cm. across, peltate, nearly orbiculate, dark green and shinning above, greenish or dull purplish-brown beneath, above glabrous, below sparsely to densely puberulent or rarely glabrous; *veins* 9 pairs, venation radiate and prominent centrally, midrib narrow ridge, abaxially sparsely to densely puberulent; margins spinose-dentate; petiole terete, greenish-brown, pubescent**.** Stipules present as a narrow transparent wing on either side of the petiole at base. **Flowers** 12–25 cm in diam., night flowering. **Sepals** four, broadly ovate, round at the apex, pure green on back, white at base, with 10–16 creamy white, prominent veins, covered margin and inside white. **Petals** 16–20, oval, broadly rounded at apex, four outermost green along middle of outside, other wise white. **Stamens** 75, yellow, outer ones with connective appendage projecting less than 2 mm beyond anther; filaments widest below middle, slightly shorter to longer than anthers. **Ovary** 20(–30)-locular, stigmatic appendages 6–12 mm, disk linear. Fruit a globose berry with remnant of stamens at apex, calyx and enlarged outer filaments persistent. **Seeds** ellipsoid, 1.4–1.8 × 0.9–1.2 mm, ca. 1.5–1.6 times as long as broad, with longitudinal ridges bearing papillae 20–150 μm (Figure 59).

Specimens examined: — NORTHERN: Chiang Mai. Mae Rim District, Ban Hong Nai, *W. La-ongsri 387* (QBG). **Lumpang.** Ban Hua Kang, Tambon Wichai *W. La-ongsri 368* (QBG).

Distribution. — This African *Nymphaea* is sometimes found escaped from cultivation in ponds, ditches and canals at 0-100 m in Thailand.

Vernacular: — Bua khao (บัวขาว), Sawet ubon (เศวตอุบล), Bua sai khao (บัวสายขาว)

Uses: — As ornamental plants. The young peduncles are eaten as a vegetable.

Note. — Flowering in spring-summer

Figure 59. *Nymphaea lotus* L.

A. habitat and habit; B. leaf blade, note orbicular outline and dentate margin; C. flower; D. flower long section showing long, linear stigmatic appendages, note lacking dental appendages on stamen.

***4. Victoria amazonica* (Poepp.) Sowerby**

Victoria amazonica (Poepp.) Sowerby, in Ann. and Mag. Nat. Hist. ser. 2, 6: 310. 1850. — *Euryale amazonica* Poepp. In Frorieps Notizen 35: 131. 1832. — *Nymphaea victoria* R. H. Schomb. Ex Lindl., Victoria regia 3. 1837, pro syn. (Edwards's Bot. Reg. 24: misc. 11. 1838, pro syn.) *nom. inval.* — *Victoria amazonica* Planch. ex Casp., Fl. bras. 4(2):152. 1869 (non (Poepp.) J. C. Sowerby 1850). — *Victoria regia* Lindl., Bot. Reg. 24: misc. 13. 1838. — *Victoria regia* var. *randii* Hort. ex Conard, Stand. cycl. hort. 6:3468. 1917, pro syn. *nom. inval.* — *Victoria regina* R. H. Schmb., Athenaeum J. no. 545. 1837 Sep 9

Leaves peltate, orbicular, up to 2 m in diam., yellowish green above and coppery red beneath, lower surface of the leaf and stems have sharp prickles; margin turned up at right angles to the water surface to a height of 3-10 cm.; juvenile leaves linear, sagittate, ovate to orbicular. Petiole densely prickly. **Flowers** nocturnal, creamy white the first day, become pink the second, then purplish red the third day before dying, 20 to 30 cm in diam.; strongly fragrant. Sepals 4, pinkish-green to purple-brown, with prickles, entire, acute. Petals numerous, longer than sepals, white, gradually turning to dull crimson, entire, acute. **Stamens** numerous, 3 cm, linear lanceolate. **Ovary** inferior, densely prickly, numerous carpels, united; stigmatic disc obconical. **Fruits** berry with prickle. **Seeds** many, ovoid to elliptic-globose, brownish-black with pulpy aril (Figure 60).

Distribution: — South America: Guyana, Brazil, Bolivia; Bangladesh; Cultivated in Thailand

Vernacular: — Bua kra dong (บัวกระด้ง), Bua victoria (บัววิคตอเรีย)

Uses: — As ornamental plants. The young peduncles are eaten as a vegetable

Note: — This is the giant water lily of the Amazon, occasionally grown in water gardens for its enormous leaves and flowers. It grows in ponds of Queen Sirikit Botanic Garden, Kasetsart University, Suan Luang Rama IX Public Park and is cultivated on a farm in Nontha Buri, Tonburi, Bangkok province.

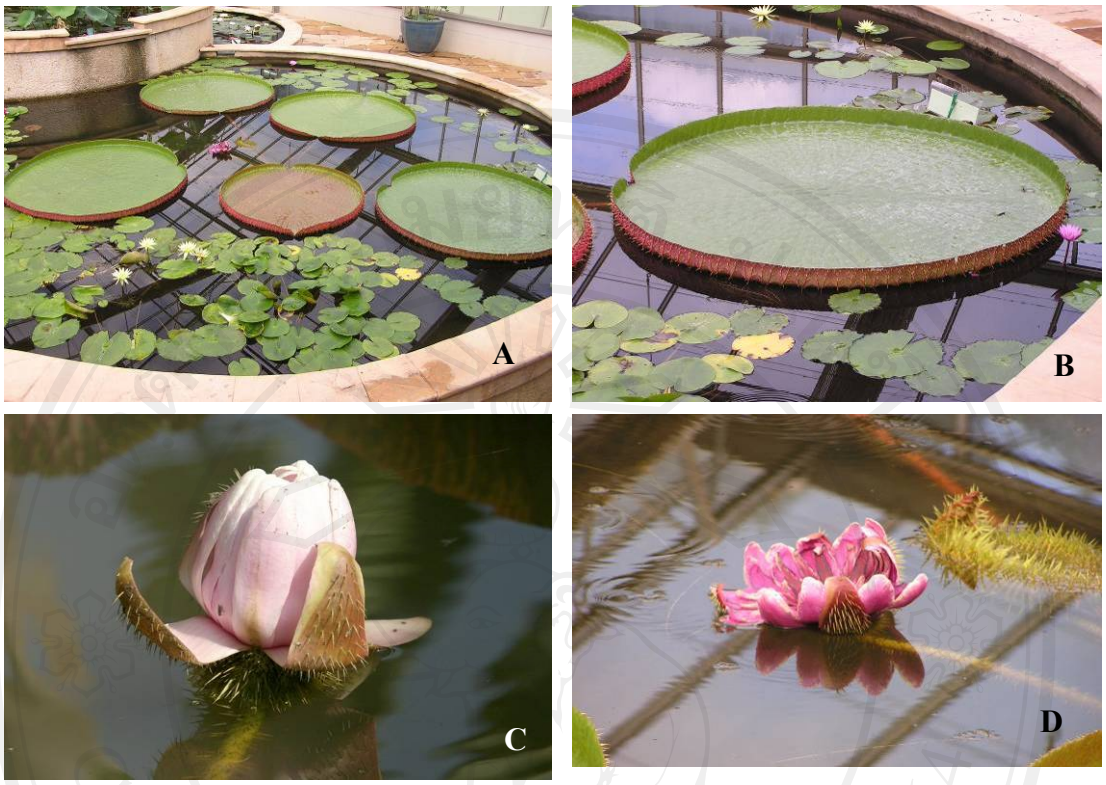

Figure 60. *Victoria amazonica* (Poepp.) Sowerby
A. habitat and habit; B. leaf blade, note orbicular outline and margin turned up at right angles to the water surface; C. flower on first day; D. flower on third day.

DISCUSSION

Taxonomy of Nelumbonaceae and Nymphaeaceae

As a result of the field surveys combined with the study of herbarium collections of the Thai flora, one species of Nelumbonaceae, which is *Nelumbo nucifera* Gaertn., was found. It has many different forms, varying in flower-color and the number of petals. The flower size, the blooming-season, the plant-height and leaf-size vary depending on the growing conditions, but the flower-color, and the number of petals are all fixed for each plants. These are then classified according to the color, and the number of petals in each flower.

In Nymphaeaceae, three genera, *Nymphaea*, *Barclaya*, and *Victoria* out of the ten genera which are mentioned for the family by Cronquist (1981) *(Barclaya, Brasenia, Cabomba, Ceratophyllum, Euryale, Nelumbo, Nuphar, Nymphaea,*

Ondinaea, Victoria) were found. Only two genera of Nymphaeaceae, *Nymphaea* and *Barclaya* are native to Thailand with four species of *Nymphaea* and two species of *Barclaya*. In the genus *Barclaya*, only *Baclaya longifolia* Wall. was found in nature. *Barclaya Kunstleri* Ridl., that was recorded in the Florae Siamensis Enumerastio (Craib, 1931; Suvatabandh, 1958; Suvatti, 1978; Sriphen, 2000) was never found in this study even when consulting Thai herbarium specimen collections (Table 5). Suvatti (1978) and Smitinand (2001) also reported *Nymphaea mexicana*, however, that species could not find neither in the nature nor among herbarium specimens.

Table 5. Comparison of Thai Nelumbonaceae and Nymphaeaceae names mentioned in different literature sources.

Species	Ridley 1911	Schmidt 1916	Craib 1931	Suvatabandh 1957, 1958	Suvatti 1978	Wasuwat 1994	Sriphen 2000	Smitinand 2001	This study
B. longifolia	×		×	×	×		×	×	×
B. kunstleri			×	×	×		×		
B.. motleyi				×	×		×		×[dry specimen]
N. stellata var *parviflora [=N. nouchali]*	×								
N. stellata [=N. nouchali]		×	×	×		×	×	×	×
N. cyanea			×	×	×	×	×	×	×
N. lotus var. *pubescens[=N. pubescens]*			×	×	×			×	×
N. lotus				×	×	×	×		×
N. rubra						×			×
N. rubra var. *rosea[=N. rubra]*						×			

Table 5. (continued)

Species	Ridley 1911	Schmidt 1916	Craib 1931	Suvatabandhu 1957, 1958	Chote 1978	Wasuwat 1994	Sriphen 2000	Smitinand 2001	This study
N.capensis var. zanzibariensis [cultivate]				×	×	×		×	×
N. maxicana					×			×	
N. versicolor[=N. nouchali]					$\times_{cf}$				
N. ' Lin Jong'						×			
N. 'Jongkolnee' [cultivate]						×			×
Victoria amazonica [cultivate]				×	×	×	×		×
Nelumbo nucifera		×	×	×	×	×	×	×	×
Total (species) 17	2	2	5	10	11	10	8	7	11

Distribution

In Thailand Nymphaeaceae and Nelumbonaceae are found in open water of large swamps, lakes, ponds, shallow ditches and also in the extensive marshes that occur in all regions, especially *Nelumbo nucifera* Gaertn., *Nymphaea nouchali* Burm. f., *Nymphaea pubescens* Willd., and *Nymphaea rubra* Roxb. ex Salisb., that are distributed in every floristic regions. However, some species seem to be limited to a particular area, *i.e., Nymphaea cyanea* Roxb. was found in the northern, northeastern , eastern and central regions of Thailand. The genus *Barclaya* was found in slow-flowing streams in tropical evergreen rain forests. *Barclaya longifolia* Wall. was recorded in the northeastern, central, southeastern and peninsular regions. The blooming season is usually from late June to the middle of September.

Nowadays many natural wetlands have been converted into cultivated field and many of them are badly affected by land reclamation and expansion of industrial areas and urban development. Lakes and ponds are becoming shallow due to decaying aquatic plants and often water ways are no longer navigable because the water surface is being covered. These developments can damage the vegetation and destroy native species, especially such ones as Nelumbonaceae and Nymphaeaceae that depend on wetlands.