Sains Malaysiana 41(12)(2012): 1503–1508

# Seed Morphology of *Parthenocissus* Planch. and *Ampelopsis* Michx. (Vitaceae) and its Taxonomic Significance

(Morfologi Biji *Parthenocissus* Planch. dan *Ampelopsis* Michx. (Vitaceae) serta Kesignifikanan Taksonominya)

A. LATIFF*

ABSTRACT

*Morphological description of seeds of* Parthenocissus *and* Ampelopsis *is given and followed by a discussion of its taxonomic significance.*

*Keywords:* Ampelopsis*; morphology;* Parthenocissus*; seeds; Vitaceae*

ABSTRAK

*Huraian morfologi biji* Parthenocissus *dan* Ampelopsis *telah diberikan dan diikuti dengan perbincangan kesignifikanan taksonominya.*

*Kata kunci:* Ampelopsis*; biji; morfologi;* Parthenocissus*; Vitaceae*

## INTRODUCTION

The Vitaceae is a family of 14 genera and well over 650 species, widely distributed in the tropics and subtropics, with geographical ranges extending into the temperate zones. The genus *Vitis* L. comprises of about 60 species and is well distributed in America, Europe and Africa, with a few species in Asia; *Ampelocissus* Planch. and *Cissus* L. are largely pantropical, seem to centre in Tropical America, Africa and Indo-Malesia, including a few species in Australia; *Nothocissus* (Miq.) Latiff and *Pterisanthes* Blume are typically Malesian; *Cayratia* Juss. is centred in Africa and Australasia; *Tetrastigma* (Miq.) Planch. is distributed in Africa and Australasia; *Rhoicissus* Planch. is typically African while *Cyphostemma* (Planch.) Alston is distributed from Africa to Thailand; *Clematicissus* is endemic to Australia; *Pterocissus* is endemic to central America; *Acareosperma* Gagnep. is little known and only confined to Indochina, *Yua* C.L.Li is confined to China and the genera *Ampelopsis* Michx. and *Parthenocissus* Planch. are confined to the northern hemisphere, with species diversity in eastern Asia and eastern North America. The family is related to Rhamnaceae from which it differs in the climbing habit, the hypogynous flowers, the anatropous ovules, the 2-ovulate locules, the tricolporate pollen, the fruit type and the ruminate endosperm.

The genus *Parthenocissus* was established by Planchon (1887) and consists of ca. 13 species and shows a disjunct distribution between Asia and North America. In the Old World, there are ca. 10 species distributed primarily in eastern Asia, two species in Indo-Malesia with one species, *P. semicordata* in India and Sri Lanka through to Peninsular Malaysia, the other species, *P. heterophylla* in Java to northern Thailand, southern Vietnam including Peninsular Malaysia and three in North America (Chen & Manchester 2007; Soejima & Wen 2006). The genus *Ampelopsis* was established by Michaux (1803) and consists of ca. 19 species and shows similar disjunct distribution as *Parthenocissus,* in subtropical Asia and North America. Similarly, in the Old World there are ca. 14 species, distributed primarily in eastern Asia, in Malesia there are two species, *A. cantoniensis* in Java, Celebes and Peninsular Malaysia, the other *A. heterophylla* in the Philippines. The taxonomy of the Malesian species of both genera poses some problems of identification and relationship with their Asiatic counterparts (Soejima & Wen 2006).

According to Chen and Manchester (2007) and Miki (1966), the seed shells of Vitaceae are well preserved as remains and offer excellent materials for the identification of the genera. This is proven by many reports (e.g. Tiffney & Barghoorn 1976). The precedent for recognising Vitaceae fossil taxa was set by Berry (1929), Chandler (1961, 1962), Reid and Chandler (1933) and Tiffney and Barghoorn (1976). Apparently little is known and understood of the morphological and anatomical variation in seeds of the extant Vitaceae. Except for the survey of Miki (1966) and Tiffney and Barghoorn (1976), there has been inadequate systematic treatment of vitaceous seeds. Latiff (1994) provided a systematic description of seeds of modern taxa belonging to nine genera in Malesia.

The two genera have previously given some difficulties in taxonomy as both possess inflorescences which are very similar, corymbose cymes in *Ampelopsis* and dichotomous cymes in *Parthenocissus* and in

many cases they also possess remnants of tendrils as in *Pterisanthes* and *Ampelocissus*. In addition, these genera demonstrated an Asian-New World disjunct distribution, suggesting multiple intercontinental migrations in the family. However, using three chloroplast markers, they are shown to be separated in different clades (Soejima & Wen 2006).

The objectives of this paper were to provide the descriptions of seeds of the two genera, namely *Parthenocissus* and *Ampelopsis* as an extension of the above account and also to demonstrate the taxonomic importance of seed morphology.

## Materials and Methods

The materials used in this study were obtained from the herbarium specimens lodged in the Herbarium, Chengdu Institute of Biology, Academica Sinica, Chengdu, China, made available at the courtesy of the late Prof. Li Chaoluan. The additional samples were obtained from Herbarium, Royal Botanic Gardens, Kew and National Herbarium the Netherlands at Leiden. The materials studied were as Table 1.

TABLE 1. The species and materials of *Parthenocissus* and *Ampelopsis* studied

| |
|---|
| *Parthenocissus heterophylla* (Blume) Merrill. CHINA, Sichuan, Hu & He 11253 |
| *P. tricuspidata* Planch. CHINA, Anhui, Huang Shan, Zhou 817 |
| *P. dalzielii* Gagnep. CHINA, Zhejiang,Shunxi, He 26792 |
| *P. laetevirens* Rehder. CHINA, Zhejiang, Longquan, Anon. 8987 |
| *P. henryana* Graebn. Ex Diels. CHINA, Shaanxi, Chengxian, Anon. 4083 |
| *P. semicordata* (Wall.) Planchon, PENINSULAR MALAYSIA, Perak, Scortechini 313 |
| *Ampelopsis bodinieri* (leveille & Vaniot) Rehder. CHINA, Sichuan, Fengjie, Fang 24744 *A. glandulosa* (Wall.) Momiyama. CHINA, Guizhou, Xinyi Anon. 7154 |
| *A. humulifolia* Bunge. CHINA, Hebei, Beizhahe, Wang 135 |
| *A. delavayana* Planch. CHINA, Sichuan, Fang 3417 |
| *A. aconitifolia* Bunge. CHINA, Shenxi, Tianmushan, Liou 7997 |
| *A. japonia* Makino. CHINA, Jiangsu, Fang 143 |
| *A. megalophylla* Diels & Gilg. CHINA, Sichuan, Chengdu, Anon. 101831 |
| *A. cantoniensis* (Hook. & Arn.) K. Koch. CHINA, Guangdong, Liannan, Tan 59132 |
| *A. chaffanjoni* (Leveille) Rehder. CHINA, Hunana, Yizhang, Liu 9113 |
| *A. heterophylla* (Thunb.) Sieb. & Zucc., INDONESIA, Sulawesi, Koorders 15092 |

The systematic description of the seed morphology follows those of Latiff (1994) and Tiffney and Barghoorn (1974)

## Seed Morphology of *Parthenocissus*

The genus *Parthenocissus* contains of 13 species, widely distributed in the subtropical areas of Asia, Europe and North America. Chen and Manchester (2007) and Latiff (1994) gave a description of the seeds of *Parthenocissus* and the following description is based on those.

*P. heterophylla* The size of the seeds is 0.9 mm × 0.7 mm. The shape is plano-convex, the outline obovate. The beak is blunt. The definitive chalaza clavate, recessed, extending half-way the dorsal surface. The chalaza-apex groove deep, narrow. Testa smooth. The apical notch shallow, wide. The ventral infolds linear, deep, converging, extending full-way of the ventral surface. The raphal ridge recessed (Figure 1(a)).

*P. semicordata* The size of the seed is 0.5 mm × 0.4 mm. The shape is plano-convex, the outline obovate, the beak is somewhat blunt. The definitive chalazal knot elliptical, depressed, extending half-way the dorsal surface. The chalazal-apex groove deep, narrow. Testa smooth. The apical notch shallow, wide. The ventral infolds narrow almost linear, parallel, extending full-way of the ventral surface. The raphal ridge recessed.

*P. tricuspidata* The size of the seeds is 1.1 mm × 1.0 mm. The shape is plano-convex, the outline obovate. The beak is quite prominent. The definitive chalaza recessed, suborbicular, somewhat irregular, extending half-way the dorsal surface. The chalaza-apex groove linear, deep. Testa smooth. The apical notch shallow. The ventral infolds linear, deep, converging, extending full-way of the ventral surface. The raphal ridge linear, recessed (Figure 1(b)).

*P. dalzielii* The size of the seeds is 0.9 mm × 0.9 mm. The shape is plano-convex, the outline suborbicular. The beak is prominent. The definitive chalaza recessed, suborbicular, with some radiating features, extending half-way the dorsal surface. The chalaza-apex groove narrow, recessed. Testa smooth, with some radiating grooves laterally from the margin. The apical notch shallow, wide. The ventral infolds linear, deep, converging, extending almost full-way of the ventral surface. The raphal ridge prominent (Figure 1(c)).

*P. laetevirens* The size of the seeds is 0.9 mm × 0.8 mm. The shape is plano-convex, the outline obovate. The beak is prominent. The definitive chalaza rectangular, recessed, extending half-way the dorsal surface. The chalaza-apex groove narrow, linear, deep. Testa smooth. The apical notch shallow. The ventral infolds linear, deep, converging, extending full-way of the ventral surface. The raphal ridge prominent (Figure 1(d)).

*P. henryana* The size of the seeds is 0.8 mm × 0.7 mm. The shape is plano-convex, the outline obovate. The beak is prominent. The definitive chalaza suborbicular to oblong, recessed, extending half-way the dorsal surface. The chalaza-apex groove linear, deep. Testa smooth. The apical notch shallow. The ventral infolds linear, deep, converging, extending three-quarter-way of the ventral surface. The raphal ridge prominent (Figure 1(e)).

SEED MORPHOLOGY OF *AMPELOPSIS*

Chen and Manchester (2007) and Latiff (1994) gave the description of the seeds of *Ampelopsis* and the following for the studied species is based on those.

*A. bodinieri* The size of the seeds is 0.7 mm × 0.7 mm. The shape is convex-carinate, the outline obovate to suborbicular. The beak is blunt. The definitive chalaza clavate, recessed, extending full-way the dorsal surface. The chalaza-apex groove shallow, wide. Testa smooth. The apical notch inconspicuous. The ventral infolds shallow, small, wide, converging, extending half-way the ventral surface. The raphal ridge prominent (Figure 1(f)).

*A. heterophylla* The size of the seeds is 0.8 mm × 0.8 mm. The shape is convex-carinate, the outline obovate. The beak is very prominent. The definitive chalaza clavate, elevated, extending half-way the dorsal surface. The chalaza-apex groove shallow, almost rounded. Testa smooth. The apical notch shallow, wide. The ventral infolds shallow, wide, extending half-way the ventral surface, converging. The raphal ridge prominent (Figures 1(g) & (j)).

*A. humulifolia* The size of the seeds is 0.9 × 0.7 mm. The shape is convex-subcarinate, the outline obovate to suborbicular. The beak is prominent, curved to one side. The definitive chalaza clavate, elevated, extending half-way the dorsal surface. The chalaza-apex groove shallow, almost truncate. Testa smooth. The apical notch inconspicuous, wide. The ventral infolds linear, quite deep, converging, extending almost three-quarter-way the ventral surface. The raphal ridge less prominent (Figure 1(h)).

*A. delavayana* The size of the seeds is 0.7 mm × 0.7 mm. The shape is convex-carinate, the outline suborbicular. The beak is less prominent. The definitive chalaza rectangular, elevated, extending three-quarter-way the dorsal surface. The chalaza-apex groove inconspicuous, wide. Testa smooth. The apical notch inconspicuous. The ventral infolds shallow, wide, converging, extending half-way the ventral surface. The raphal ridge prominent (Figure 1(i)).

*A. aconitifolia* The size of the seeds is 0.9 mm × 0.6 mm. The shape is convex-carinate, the outline obovate to suborbicular. The beak is quite prominent. The definitive chalaza clavate, elevated, extending half-way the dorsal surface. The chalaza-apex groove wide, shallow. Testa smooth. The apical notch inconspicuous. The ventral infolds deep, wide, converging, with some radiating grooves, extending half-way the ventral surface. The raphal ridge prominent (Figure 1(k)).

*A. japonica* The size of the seeds is 0.9 mm × 0.6 mm. The shape is convex-carinate, the outline obovate. The beak is very prominent. The definitive chalaza clavate, elevated, extending half-way the dorsal surface. The chalaza-apex groove inconspicuous, almost rounded. Testa smooth. The apical notch inconspicuous. The ventral infolds linear, deep, converging, extending three-quarter-way the ventral surface. The raphal ridge less prominent (Figure 1(l)).

*A. megalophylla* The size of the seeds is 0.7 mm × 0.6 mm. The shape is convex-carinate, the outline triangular or obovate. The beak is less prominent. The definitive chalaza clavate, elevated, extending half-way the dorsal surface. The chalaza-apex groove incospicuous, almost rounded. Testa ridged, radiating laterally from the margin. The apical notch inconspicuous, almost rounded. The ventral infolds wide, shallow, with radiating ridges, parallel, converging, extending three-quarter-way the ventral surface. The raphal ridge prominent (Figure 1(m)).

*A. cantoniensis* The size of the seeds is 1.0 mm × 0.8 mm. The shape is convex-carinate, the outline obovate. The beak is less prominent. The definitive chalaza clavate, elevated, extending half-way the dorsal surface. The chalaza-apex groove shallow, inconspicuous. Testa ridged, radiating laterally from the margin. The apical notch inconspicuous, wide. The ventral infolds deep, parallel, wide, with radiating grooved, converging, extending three-quarter-way the ventral surface. The raphal ridge very prominent (Figure 1(n)).

*A. chaffanjoni* The size of the seeds is 0.7 mm × 0.7 mm. The shape is convex-carinate, the outline obovate. The beak is inconspicuous. The definitive chalaza clavate, recessed, extending half-way the dorsal surface. The chalaza-apex groove shallow, wide. Testa manifestly ridged, radiating laterally from the margin. The apical notch inconspicuous. The ventral infolds quite deep, with some radiating grooves, converging, extending three-quarter-way the ventral surface. The raphal ridge very prominent (Figure 1(o)).

## Discussion

From the present study of the external morphology of seeds of six and ten species of *Parthenocissus* and *Ampelopsis*, respectively, it is shown that the seeds are not highly variable in size, shape and other salient features. However, the variation observed in those characters are within limits of the circumscription of the two genera and are significant enough for distinguishing both of them and the species within them. A key to the genera is herein given.

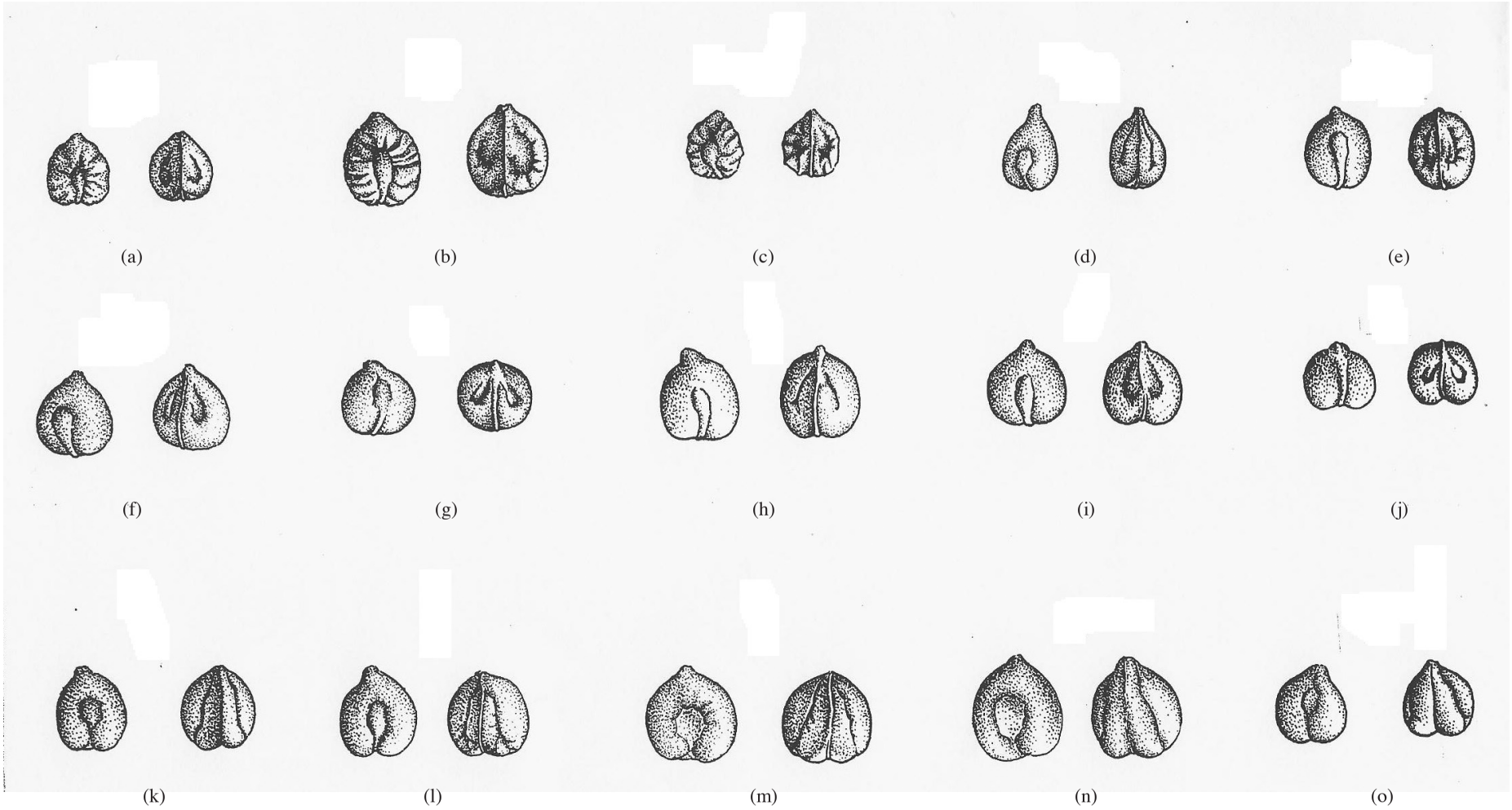


FIGURE 1. Seed morphology of *Parthenocissus* and *Ampelopsis*, (a). *P. heterophylla*, (b). *P. tricuspidata*, (c). *P. dalzielii*, (d). *P. laetevirens*, (e). *P. henryana*, (f). *A. bodinieri*, (g) & (j). *A. glandulosa* (h). *A. humulifolia*, (i). *A. delavaya*, (k). *A. aconitifolia*, (l). *A. japonica*, (m). *A. megalophylla*, (n). *A. cantoniensis* and (o). *A. chaffanjoni*

KEY TO THE GENERA BASED ON SEED MORPHOLOGY

1(a). Seeds plano-convex; dorsal surface smooth; definitive chalaza recessed; chalaza-apex groove linear; ventral infolds linear, extending mostly full-way, rarely 3/4-way the ventral surface; raphae recessed. ..... *Parthenocissus*

1(b). Seeds carinate-convex; dorsal surface smooth or prominently ridged or cereberiform; definitive chalaza raised or elevated; chalaza-apex groove wide; ventral infolds linear or wide and diversging, extending mostly half-way, rarely 3/4-way of ventral surface; raphae carinate. ..... *Ampelopsis*

SEED VARIATION WITHIN *PARTHENOCISSUS* AND TAXONOMIC SIGNIFICANCE

Generally, the seed morphology of the five species studied is quite homogenous. The size, shape and testa ornamentation are within the limit of the genus (Chen & Manchester 2007; Latiff 1994). However, those of *P. heterophylla* are relatively smaller. The shape is ovoid in all species. The chalaza shape varies somewhat, clavate in *P. laetevirens* (Figure 1(d)), *P. henryana* (Figure 1(e)) and *P. heterophylla* (Figure 1(a)) and more or less suborbicular in *P. tricuspidata* (Figure 1(b)) and manifestly radiating in *P. dalzielii* (Figure 1(c)). The ventral infolds are always converging but their extent on the ventral surface of the seeds is diagnostic for some species. They extend full-way the ventral surface in *P. heterophylla* (Figure 1(a)), *P. tricuspidata* (Figure 1(b)) and *P. henryana* (Figure 1(e)), whereas in *P. dalzielii* (Figure 1(c)) and *P. laetevirens* (Figure 1(d)) they are between half-way and three-quarter-way the ventral surface. The beak is prominent and the testa is smooth in all species. Overall seed morphology of the species studied had proven useful in species identification as shown above. However, it would be more significant taxonomically if seeds of all the 13 species in the world are available for comparison. The two species in Malesia may be differentiated by their seed size, those of *P. heterophylla* are bigger than those of *P. semicordata,* in addition to other morphological characters.

Two infrageneric classification systems have been proposed for the genus. Galet (1967) recognized three series based on leaves morphology: series *Tricuspidatae* (*P. cuspidata*), series *Trifoliolae* (*P. heterophylla, P. semicoradata, P. dalzielii*) and series *Quinquefoliolae* (*P. henryana, P. laetivirens*). Based on tendril morphology, Li (1998) divided the Chinese species of *Parthenocissus* into three sections: sect. *Parthenoscissus (P. heterophylla, P. semicoradata*), sect. *Margaritaceae* (*P. dalzielii*) and sect. *Tuberculiformes* (*P. henryana, P. laetivirens*). Unfortunately the above series and sections recognized are not supported by seed morphology in this study.

SEED VARIATION WITHIN *AMPELOPSIS* AND TAXONOMIC IMPLICATIONS

In *Ampelopsis* seed morphology is very consistent and previously it was used to describe new fossil species (Miki 1966; Reid & Chandler 1933). In the species studied some variations are observed and herein discussed. The shape and size are within the limit of the genus. However, those of *A. bodinieri* (Figure 1(f)) and *A. megalophylla* Figure 1(m)) are relatively smaller. The shape is obovoid in all species but with minor variation. The definitive chalaza extends the full-way in *A. bodinieri* (Figure 1(f)), three-quarter-way in *A. devalayana* (Figure 1(i)) and *A. aconitifolia* (Figure 1(k)) and half-way of the dorsal surface of the seeds in other species. The ventral infolds are almost linear in *A. humulifolia* (Figure 1(h)) and *A. japonica* (Figure 1(n)) but in other species they are wide and obovate in outline. The beak is prominent in all species. On the basis of testa ornamentation the genus could be divided into two groups: Group 1. Testa smooth in both surfaces, e.g. *A. bodinieri, A. glandulosa, A. humulifolia, A. aconitifolia* and *A. japonica* and Group 2. Testa ridged on the dorsal surface, e.g. *A. megalophylla, A. cantoniensis* and *A. chaffanjoni*. Generally, seed morphology of the species studied had proven useful in species identification as shown above. Likewise, it would be more significant taxonomically if seeds of all the 19 species in the world are available. But the two species in Malesia may be differentiated by their seed size, those of *A. heterophylla* are bigger than those of *A. cantoniensis,* in addition to other morphological characters.

## CONCLUSION

Studies on seed morphology of two disjunct subtropical genera of Vitaceae, *Parthenocissus* and *Ampelopsis* consisting of six and ten species, respectively, provided a fairly significant results for generic and species identification. The seed morphology alone is not that useful in the taxonomy of the two genera without the inclusion of the flower, leaves and inflorescence morphologies. The Malesian species of *Parthenocissus* and *Ampelopsis* may be differentiated by seed size.

ACKNOWLEDGEMENTS

The author would like to thank the late Prof. Li Chaoluan, Chengdu Institute of Biology, Academica Sinica, Chengdu, China for providing the materials and drawing the figures and UKM-OUP-PLW-13-56-2011 and UKM-OUP-2012-056 for the financial support.

## REFERENCES

Berry, E.W. 1929. Seeds of a new species of Vitaceae from the Wilcox Eocene of Texas. *J. Wash. Acad. Sci.* 19: 39-41.

Chandler, M.E.J. 1961. *The Lower Tertiary Floras of Southern England. I. Eocene floras. The London Clay Flora*

*(supplement)*. British Museum (Natural History). London. p. 354.

Chandler, M.E.J. 1962. *The Lower Tertiary Floras of Southern England. II. Flora of the Pipe-Clay series of Dorset (Lower Bagshot)*. British Museum (Natural History), London.

Chen, I. & Manchester. S.R. (Vitaceae) and implication for phytogeography. *American Journal of Botany* 94(9): 1534-1553.

Galet, P. 1967. Recherches sur les methods d'identification et de classification des Vitacees temperees. II These. University de Montpellier, Montpellier, France.

Latiff, A. 1994. On the seeds of modern and fossil taxa of Vitaceae. *Malays. Appl. Biol.* 22(1): 97-106.

Li, C.L. 1998. Vitaceae. In *Flora Reipublicae Popularis Sinicae* Vol. 48(2): 1-177. Beijing: Science Press.

Michaux, A. 1803. *Flora Borealis-americana sisten characters plantarum quas* 1: 159. Paris and argentorati.

Miki, S. 1966. Seed remains of Vitaceae in Japan. *J. Inst. Polytech.* Osaka City University, Series D. 7: 247-271.

Planchon, J.E. 1887. Monographie des Ampelidees vrais. In *Monographiae Phanerogamarum,* edited by de Candolle, A. & C. de Candolle. 5: 305-654, Paris: G Masson.

Reid, E.M. & Chandler, M.E.J. 1933. *The London Clay Flora*. British Museum (Natural History), London.

Soejima, A. & Wen, J. 2006. Phylogenetic analysis of the grape family (Vitaceae) based on three chloroplast markers. *American Journal of Botany* 93(2): 278-287.

Tiffney, B.H. & Barghoorn, E.S. 1976. Fruits and seeds of the Barndon lignite. I. Vitaceae. *Rev. Palaeob. & Palyn.* 22: 169-191.

Pusat Pengajian Sains Sekitaran dan Sumber Alam
Fakulti Sains dan Teknologi
Universiti Kebangsaan Malaysia
43600 UKM Bangi
Selangor Darul Ehsan
Malaysia

*Corresponding author; email: latiff@ukm.my

Received: 25 January 2012
Accepted: 6 August 2012