

Survey of the Menispermaceae endocarps

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ABSTRACT

Menispermaceae endocarps were very much used for long in the classification of this family. This organ also presents a definite palaeobotanical interest as it is often present in fossil state. The lack of a detailed knowledge on the endocarps of extant Menispermaceae limits the identification of those fossils. The present paper tries to fill this lack, describing endocarps of 116 species belonging to 55 different genera. The whole Menispermaceae family has drupaceous fruits, but there is an important morphological diversity of the endocarps, the differences between affiliated species being sometimes very slight. However, the comparisons with molecular phylogenies show that the differences between endocarps have a phylogenetic significance, to some extent. Menispermaceae endocarps are straight or underwent an often important curvature during their development. Almost all of these endocarps show a peculiar structure known as a condyle, which can have different aspects. Some characters, such as the endosperm structure and the style scar position on the pericarp, depend of endocarp characters, at least partially and with a few exceptions. Hypotheses on endocarp adaptation are limited by the lack of knowledge on the seed dispersal of this family. A key of the studied genera is proposed.

KEY WORDS

Menispermaceae,
fruit,
endocarp,
condyle.

RÉSUMÉ

Étude des endocarpes de Menispermaceae.

Les endocarpes de Menispermaceae ont longtemps été très utilisés pour la classification de la famille. Cet organe présente également un intérêt paléobotanique certain puisqu'il est fréquemment retrouvé à l'état fossile. L'identification de ces fossiles est parfois limitée par l'absence de données précises sur les endocarpes de Menispermaceae actuelles. Le présent article essaye de combler ce manque en décrivant les endocarpes de 116 espèces appartenant à 55 genres différents. Les membres de la famille des Menispermaceae ont en commun d'avoir des fruits drupacés, mais il existe une grande diversité morphologique des endocarpes, les différences entre espèces proches étant parfois minimes. Les comparaisons avec les phylogénies moléculaires montrent que les différences entre endocarpes ont, dans une certaine mesure, une signification phylogénétique. Les endocarpes de Menispermaceae sont droits ou ont subi une courbure, souvent assez importante, durant leur développement. Ces endocarpes présentent quasiment tous une structure particulière connue sous le nom de condyle, qui peut prendre des aspects assez variables. Certains caractères, comme la structure de l'albumen et la position de la cicatrice du style sur le péricarpe, dépendent, au moins en partie et avec quelques exceptions, des caractères de l'endocarpe. Les hypothèses sur les adaptations des endocarpes sont limitées par le manque de connaissance de la dispersion des diaspores de cette famille. Une clé des genres étudiés est proposée.

MOTS CLÉS

Menispermaceae,
fruit,
endocarpe,
condyle.

INTRODUCTION

The classification of Menispermaceae is principally based on the fruit characters (Diels 1910). It is always drupaceous, but with strong variations in the shape of the endocarp. In Menispermaceae fossils collections, endocarps are often represented (Reid & Chandler 1933; Chesters 1957a; Manchester 1994; Jacques & De Franceschi 2005). The palaeobotanists need to have a good knowledge of extant Menispermaceae to propose the best affinities for these fossils (Tiffney 1990). However no information on these endocarps is available, except for a few species (Forman 1974; Botha 1980). Thanikaimoni (1984) proposed an atlas of Menispermaceae endocarps, but only with very short descriptions at the generic level with no reference to the general shape of the endocarp. The elusive descriptions are not very usable for phylogenetic analysis. The present study tries to fill this lack.

Recent molecular phylogenetic analyses of the family (Ortiz *et al.* 2007; Wang *et al.* 2007) did not discuss the implications of their phylogeny on the evolution of endocarps. We try to link our results to their phylogenies.

The endocarps of 116 species of 55 genera are presented here. So 75% of the family genera are described, and belong to all tribes traditionally recognized in Menispermaceae (Diels 1910; Kessler 1993).

MATERIAL AND METHODS

ENDOCARP PREPARATION

Endocarps were obtained from fruits mainly removed from herbarium sheets (BM, L, P, U and personal collections). Fruits were first hydrated (a few minutes in boiling water and then overnight in water). Then pericarp and mesocarp were separated using fine pliers and/or a small sharp scalpel. The

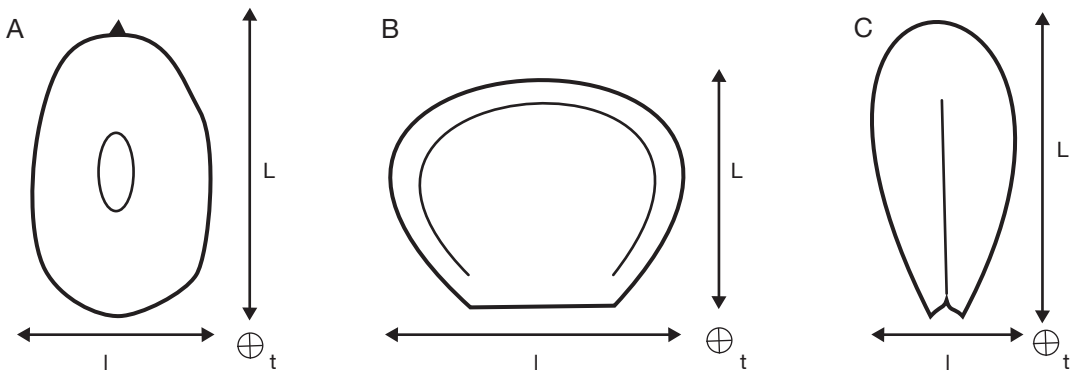


FIG. 1. — Measurements of different types of Menispermaceae endocarps: **A**, ventral view; **B**, **C**, lateral views. Abbreviations: **L**, length; **l**, width; **t**, thickness.

adhesion of the mesocarp to the endocarp is highly variable, even intraspecifically. We think this variability is linked to differences in species, maturity and drying process. When hydrated, spines (found on some endocarps) are generally slightly flexible, but they are easily broken when dried; they must be carefully handled.

For herbarium sheets preservation reasons, the number of endocarp specimens for each species is generally low (1 to 3). However, we decide to describe them, because this can bring some information, and some species are also known from only a few vegetative specimens.

ENDOCARP STUDY AND DESCRIPTION

Endocarps are generally measured with the graduated scale of binocular microscope eyepiece; for larger endocarps, a ruler is used. Endocarp measurements are only geometrical (Fig. 1): thickness was measured perpendicularly to the longitudinal plane of symmetry in case of curved endocarp, but on it and perpendicular to base-apex line in case of straight endocarp. For the two other dimensions, length always represents the longer one and width its perpendicular. Therefore, those measurements have to be considered with caution because they are highly not homologous. This choice was made to let the measurements independent of an evolutionary model; the homologies are indeed difficult to define, as it is not clear if the curvature is always homologous.

Some words used in the descriptions might need further explanation. Groove: a linear depression at the surface of endocarp wall. Limb: apical or basal part of a curved endocarp. Condyle: trace of placenta, often represented by a ventral or lateral depression, but see Discussion for more details.

Endosperm is not always well preserved in herbarium specimens. Therefore, it is not possible to indicate if it is ruminant for each case. As the endosperm is part of the seed, and not of the endocarp, we chose not to present this tissue in detail in this study concerning endocarp (see Discussion below). The information is however available at the genus level in literature (Thanikaimoni 1984), and is indicated here only at this level.

DISCUSSION

STATISTIC CONSIDERATIONS

Due to the low number of specimens known for each species, this study does not consider intraspecific variability concerning endocarp shape and size. This should have to be made, namely about ornamentation, because it is used to discriminate between fossil species.

ENDOCARP GENERAL FEATURES

Menispermaceae endocarps show an incredible variety of unusual shapes. We were able to give a type to almost all genera (see Table 1 and Fig. 2).

TABLE 1. — Distribution of endocarp and endosperm types among Menispermaceae genera. Note that *Coscinium* has a subglobose endocarp, and endocarps of *Dialythea*, *Synandropus* and *Ungulipetalum* are unknown. Endosperm type (from Thanikaimoni 1984): A, absent; P, present and not ruminated; R, present and ruminated; V, present and ventrally ruminated; ?, no data.

Genera	Endocarp				Endosperm type	Genera	Endocarp				Endosperm type
	Hairpin-shaped	Straight	Horseshoe-shaped	Reniform			Hairpin-shaped	Straight	Horseshoe-shaped	Reniform	
<i>Abuta</i>	●				R	<i>Leptoterantha</i>		●			P
<i>Albertisia</i>	●				P	<i>Limacia</i>			●		P
<i>Anamirta</i>				●	P	<i>Limaciopsis</i>			●		P
<i>Anisocycla</i>	●				A	<i>Macrococculus</i>					A
<i>Anomospermum</i>	●				R	<i>Menispermum</i>			●		P
<i>Antizoma</i>	●				?	<i>Odontocarya</i>		●			V
<i>Arcangelisia</i>				●	R	<i>Orthogynium</i>		●			V
<i>Aspidocarya</i>		●			P	<i>Orthomene</i>		●			R
<i>Beirnaertia</i>	●				A	<i>Pachygone</i>	●				A
<i>Borismene</i>		●			P	<i>Parabaena</i>		●			P
<i>Burasaia</i>		●			V	<i>Penianthus</i>		●			A
<i>Calycocarpum</i>		●			V	<i>Pericampylus</i>			●		P
<i>Carronia</i>	●				A	<i>Platytiñospora</i>		●			V
<i>Caryomene</i>			●		R	<i>Pleogyne</i>					A
<i>Chasmanthera</i>		●			V	<i>Pycnarrhena</i>				●	A
<i>Chlaenandra</i>		●			V	<i>Rhaptonea</i>			●		A
<i>Chondrodendron</i>	●				A	<i>Rhigiocarya</i>		●			V
<i>Cissampelos</i>	●				P	<i>Sarcolophium</i>		●			V
<i>Cocculus</i>			●		P	<i>Sarcopetalum</i>			●		P
<i>Coscinium</i>					R	<i>Sciadotenia</i>			●	●	A
<i>Curarea</i>	●				A	<i>Sinomenium</i>			●		P
<i>Cyclea</i>			●		P	<i>Sphenocentrum</i>		●			A
<i>Dialythea</i>		fruit unknown				<i>Spirospermum</i>			●		A
<i>Dioscoreophyllum</i>		●			P	<i>Stephania</i>			●		P
<i>Diploclisia</i>	●				P	<i>Strychnopsis</i>			●		A
<i>Disciphania</i>		●			P	<i>Synandropus</i>		fruit unknown			
<i>Echinostephia</i>			●		P	<i>Synclisia</i>	●				A
<i>Elephantomene</i>	●				R	<i>Syntriandrium</i>		●			V
<i>Eleutarhena</i>				●	A	<i>Syrhronema</i>			●		A
<i>Fibraurea</i>		●			P	<i>Telitoxicum</i>	●				R
<i>Haematocarpus</i>	●				A	<i>Tiliacora</i>	●				R/P
<i>Hyperbaena</i>	●		●		A	<i>Tinomiscium</i>		●			?
<i>Hypserpa</i>			●		P	<i>Tinospora</i>		●			V
<i>Jateorrhiza</i>		●			V	<i>Triclisia</i>	●				A
<i>Kolobopetalum</i>		●			V	<i>Ungulipetalum</i>		fruit unknown			
<i>Legnephora</i>			●		P						

For *Dialythea* Exell & Mendonca, *Synandropus* A.C.Sm. and *Ungulipetalum* Moldenke, it was impossible because their fruits are not known. For *Macrococculus* Becc. and *Pleogyne* Miers, we could not observe personally any specimens, and were not able to give a type from literature description or illustration. The endocarps are either curved or not. A few of them are globose, and cannot be attributed

at first glance to curved or uncurved endocarps. The endocarps without curvature are of straight type. The curvature of the endocarps can involve the whole tissue or only a part of it: it is respectively characteristic of horseshoe-shaped or reniform endocarps and hairpin-shaped endocarps. To understand the differences between these types, the best would be to undertake some developmental studies.

The present study, working at the species level, tries to be as consistent as possible in its descriptions, taking into account the highly diverse shapes of the family. However, we cannot describe all species; for missing species or genera, the reader can refer to previous partial works. The Table 2 indicates the major works on Menispermaceae endocarps descriptions. Thanikaimoni (1984) described the endocarps only at the genus level and did not give indication of endocarp general shape. Forman (1956, 1957, 1968, 1972a, b, 1974, 1975, 1978, 1981, 1984, 1985, 1997) only focused on Asian species for floristic revisions; the endocarp descriptions are included in general species descriptions and are not always easily comparable between different groups.

Almost all genera show endocarps with a condyle. Only exceptions are *Arcangelisia*, *Orthomene*, *Penianthus*, *Pycnarrhena* p.p., *Sphenocentrum* and *Tinomisium*. For *Orthomene*, which is phylogenetically included in a group with a condyle (*Anomospermum*, Ortiz *et al.* 2007), it should be a secondary loss. The condyle is a structure peculiar to the Menispermaceae. Miers (1871) defined it as an enlarged and intrusive placenta. The sclerification of the placenta during fruit maturation, along with the rest of endocarp, forms the condyle. Troupin (1962) and Forman (1956, 1957, 1968, 1972a, b, 1974, 1975, 1978, 1981, 1984, 1985, 1997) only considered condyle as a depression of the endocarp. Dekker (1983) proposed an interesting and comprehensive review of the uses of this term in works on Menispermaceae. We consider that those different uses are linked with the nature of the works. Troupin (1962) and Forman (1956, 1957, 1968, 1972a, b, 1974, 1975, 1978, 1981, 1984, 1985, 1997), working on floristic revisions, were mostly interested in comparative descriptions of the species. On the other hand, Miers (1871), and later Diels (1910), were working on systematic classification of the family, and were interested in the significance of the structure and then in its ontogeny. The condyle, always ventral, has different appearances:

1) in straight endocarps, it is generally a ventral central depression, largely opened or sometimes almost closed;

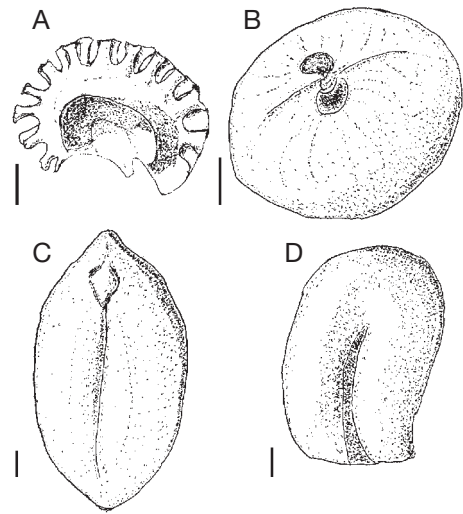


Fig. 2. — Types of endocarps in Menispermaceae: **A**, horseshoe-shaped endocarp; **B**, reniform endocarp; **C**, straight endocarp; **D**, hairpin-shaped endocarp. Scale bars: 2 mm.

2) in some curved endocarps, it is two-parted and forms two lateral depressions, this is mostly the case in horseshoe-shaped endocarps and in *Diploclisia*;

3) in other curved endocarps, the condyle is lamelliform and clearly separates the two limbs, this is mostly the case in hairpin-shaped endocarps.

In all these situations, the condyle can be either largely opened, as in *Calycocarpum*, *Menispermum* and *Tiliacora*, or covered by endocarp wall, as in *Chasmanthera*, *Limacia* and *Abuta*. Without a clear knowledge of condyle function, it is nearly impossible to see if those variations are adaptative or not.

The ornamentation of Menispermaceae endocarps is very diverse. Some endocarps are smooth, some rugose, some bear grooves, other ridges. Numerous curved endocarps, especially when they are crustaceous, bear transverse ridges (see for example *Stephania* or *Tiliacora*). The role of these ridges is not really understood, but we can propose some hypotheses: it might enforce the seed cavity, preventing it from breaking; it might be involved in the dissemination process.

The thickness of endocarps and their internal structure are variable. Indeed, the texture of endocarps varies from crustaceous to woody, with other different states possible, namely bony or papyraceous. Preliminary

TABLE 2. — Indication of major works describing the endocarp for each genus of Menispermaceae.

Genera	Present study	Thanikaimoni 1984	Forman	Genera	Present study	Thanikaimoni 1984	Forman
<i>Abuta</i>	●	●		<i>Leptoterantha</i>	●	●	
<i>Albertisia</i>	●	●	1975	<i>Limacia</i>	●	●	1957
<i>Anamirta</i>	●	●	1978	<i>Limaciopsis</i>	●	●	
<i>Anisocycla</i>	●	●		<i>Macrococculus</i>	●	●	1972a
<i>Anomospermum</i>	●	●		<i>Menispermum</i>	●	●	
<i>Antizoma</i>	●	●		<i>Odontocarya</i>	●	●	
<i>Arcangelisia</i>	●	●	1978	<i>Orthogynium</i>	●	●	
<i>Aspidocarya</i>	●	●	1984	<i>Orthomene</i>	●	●	
<i>Beirnaertia</i>	●	●		<i>Pachygone</i>	●	●	1957
<i>Borismene</i>	●	●		<i>Parabaena</i>	●	●	1984
<i>Burasaia</i>	●	●		<i>Penianthus</i>	●	●	
<i>Calycocarpum</i>	●	●		<i>Pericampylus</i>	●	●	1968
<i>Caronia</i>	●	●	1975	<i>Platylinospora</i>	●	●	
<i>Caryomene</i>	●	●		<i>Pleogyne</i>	●	●	1975
<i>Chasmanthera</i>	●	●		<i>Pycnarrhena</i>	●	●	1972a
<i>Chlaenandra</i>	●	●	1984	<i>Rhaptonea</i>	●	●	
<i>Chondrodendron</i>	●	●		<i>Rhigiocarya</i>	●	●	
<i>Cissampelos</i>	●	●	1968	<i>Sarcolophium</i>	●	●	
<i>Cocculus</i>	●	●	1974	<i>Sarcopetalum</i>	●	●	1968
<i>Coscinium</i>	●	●	1978	<i>Sciadotenia</i>	●	●	
<i>Curarea</i>	●	●		<i>Sinomenium</i>	●	●	
<i>Cyclea</i>	●	●	1960	<i>Sphenocentrum</i>	●	●	
<i>Dialythea</i>	●	fruit unknown		<i>Spirospermum</i>	●	●	
<i>Dioscoreophyllum</i>	●	●		<i>Stephania</i>	●	●	1956
<i>Diploclesia</i>	●	●	1968	<i>Strychnopsis</i>	●	●	
<i>Disciphania</i>	●	●		<i>Synandropus</i>	●	fruit unknown	
<i>Echinostephia</i>	●	●		<i>Synclisia</i>	●	●	
<i>Elephantomene</i>	●	●		<i>Syntriandrium</i>	●	●	
<i>Eleutarrhena</i>	●	●	1975	<i>Syrhonema</i>	●	●	
<i>Fibraurea</i>	●	●	1985	<i>Telotoxicum</i>	●	●	
<i>Haematocarpus</i>	●	●	1972a	<i>Tiliacora</i>	●	●	1975
<i>Hyperbaena</i>	●	●		<i>Tinomiscium</i>	●	●	1985
<i>Hypserpa</i>	●	●	1997	<i>Tinospora</i>	●	●	1981
<i>Jateorhiza</i>	●	●		<i>Triclisia</i>	●	●	
<i>Kolobopetalum</i>	●	●		<i>Ungulipetalum</i>	●	fruit unknown	
<i>Legnephora</i>	●	●	1972b				

studies under scanning electron microscope show that the cell pattern of the endocarp wall could be of great interest in future investigations: fibres are organized in different layers or not, they are oriented tangentially or radially, all with the same orientation or not. Such an analysis is delayed because of still lacking standardization of endocarp wall preparation.

PHYLOGENETIC IMPLICATIONS

Considering the recent molecular phylogenies (Ortiz *et al.* 2007; Wang *et al.* 2007), endocarp types

can be phylogenetically significant. The straight endocarps form one clade, while curved endocarps form another one. The exceptions are *Anamirta*, which is curved but belongs to the “straight” group, *Orthomene*, which is straight but belongs to the “curved” group, *Tinomiscium*, which was found as sister to all other Menispermaceae by Ortiz *et al.* (2007). The hairpin-shaped type of endocarp belongs mostly to two tribes, namely Tiliacoreae and Anomospermeae, which are not sister groups in Ortiz *et al.* (2007) result. According to the latter

analysis, the hairpin-shaped type evolved at least twice from horseshoe-shaped type.

CHARACTER VARIABILITY

Within a genus, the differences are sometimes slight between the species. For example, in the genus *Tiliacora*, the general shape is the same with one limb thinner than the other. However, some scarce differences in ornamentation are present. *Tiliacora louisii* (Fig. 12E) has an almost smooth surface; *T. ovalis* (Fig. 12G) has a dorsal median ridge; in *Tiliacora acuminata* (Fig. 12A) and *T. klaineana* (Fig. 12D), inconspicuous lateral ridges are present; in *Tiliacora macrophylla* (Fig. 12F) and *T. triandra* (Fig. 12H), those ridges are stronger; in *T. dielsiana* (Fig. 12B), the ridges tend to unify and so make two lateral chambers. In *Tinospora* Miers, there are differences in the ornamentation (smooth surface to reticulated walls) and in the size and shape of condyle aperture. In *Stephania*, there is an intrageneric variation in the ornamentation, namely the transverse ridges, and in the perforation of the condyle. In *Abuta*, the intrageneric variation is limited to size, ornamentation (depth of the grooves) and relative size of the two limbs. Forman (1985) demonstrated in *Tinomiscium petiolare* that there is a continuum in the size and flatness variations in this species. So, even if the size cannot be regarded as a discriminating character, the ornamentation of endocarps is useful to distinguish species in a genus.

Some genera present also only small differences. The endocarp of *Platytilospora* Diels (Fig. 9K) is very similar to that of *Tinospora*, but shows a more keeled apex. *Menispermum* (Fig. 8D-F) and *Sinomenium* Diels (Fig. 10I) only show slight differences, that are of the same kind as intrageneric variations of *Menispermum* and most of Menispermaceae genera. The differences between *Tinospora* and *Odontocarya* Miers or between *Sarcophium* Troupin and *Syntriandrium* Engl. are of same range as those that can be observed inside the genus *Tinospora*. The range of variations is not characteristic at intergeneric, intrageneric or intraspecific level. As consequence, the endocarp characters are not sufficient to establish a complete classification of Menispermaceae, even if some are

useful at the intertribal level (Miers 1871; Diels 1910; Kessler 1993).

LINK BETWEEN ENDOCARP AND OTHER

CHARACTERS

Rumination of endosperm was clearly observed in the following species: *Abuta grandifolia*, *Abuta imene* and *Anomospermum steyermarkii*. For other species, it remains difficult to get reliable data on this tissue without any fresh material. The information at the genus level is taken from literature (Thanikaimoni 1984) and is given in Table 1. There is no clear relationship between endocarp type and rumination of the endosperm. The ventrally ruminated endosperm is found only in straight endocarps, but the reverse is not true. The rumination of endosperm is not linked with a special ornamentation of endocarp (for example transverse ridges do not reflect rumination of endosperm).

The curvature of endocarp is often related with the position of the stylar scar on the fruit. Curved endocarps have basal or lateral stylar scars, whereas straight endocarps have a terminal stylar scar. This means that the curvature as a rule involves the whole fruit. However, in some cases, such as *Anomospermum*, the endocarp is curved but the stylar scar is almost terminal. Such cases raise the question of the homology of the endocarp curvature.

ECOLOGICAL CONSIDERATIONS

The dispersal mode of Menispermaceae seeds is not clearly understood. The endocarp of *Elephantomene eburnea* was found in the stomach of a tapir (Henry *et al.* 2000). *Cissampelos* endocarps are part of the diet of gorillas (Watts 1984), lemurs (Sussman 1977) and bushbabies (galagos; Molez-Verrière 2000). The Chiroptera, that are frequent vectors for fleshy fruits in intertropical regions, can also be proposed. However, some palaeobotanists suggested that Menispermaceae endocarps could have water dispersion (Scott 1956; Chesters 1957b). Indeed, endocarps such as *Chasmanthera* clearly remind small boats, and the proposal of adaptation to buoyancy is not surprising. However such dispersion is not proved. A better knowledge of Menispermaceae dispersal mode could lead to an improved understanding of the endocarp adaptations.

CONCLUSION

The endocarps of Menispermaceae exhibit a wide range in shape and size (from 3.2 to 59 mm). At the generic level, the general shape is similar, but there are variations in their ornamentation. The distinction between some genera is of the same order at that between species in one genus. Despite their usefulness in the classification of Menispermaceae, the use of endocarp features shows some limits.

Considering the available molecular data about Menispermaceae, the characters of the endocarp may bear some phylogenetic information. There-

fore they can be used in a morphological phylogenetical analysis of this family (Jacques & Bertolino 2008).

However, even if the morphology of Menispermaceae is better known, some biological aspects are still lacking. Developmental studies could explain the curvature process, and question the homology of the curvature in different groups. Anatomical studies of endocarp wall might bring out new characters, probably precisising the homology between endocarps. Ecological studies and better understanding of endocarp dispersal should provide new insights in the adaptative role of some endocarp features.

KEY TO MENISPERMACEAE GENERA

Endocarps of some genera are not included in this key:

– genera for which endocarps are not known (*Dialythea* Exell & Mendonca, *Synandropus* A.C.Sm., *Ungulipetalum* Moldenke);

– genera that I could not study on my own (*Antizoma* Miers, *Beinaertia* Louis ex Troupin, *Caryomene* Barneby & Krukoff, *Chlaenandra* Miq., *Curarea* Barneby & Krukoff, *Disciphania* Eichler, *Echinostephia* (Diels) Domin, *Eleutarrhena* Forman, *Haematocarpus* Miers, *Macrococculus* Becc., *Orthogynium* Baill., *Pleogyne* Miers); refer to Table 1 to see to which type they belong.

- | | |
|---|--------------------------|
| 1. Endocarp straight | 2 |
| — Endocarp not straight | 22 |
| 2. Endocarp with protruding ventral chamber | 3 |
| — Endocarp without protruding ventral chamber | 9 |
| 3. Endocarp with spines on dorsal face | 4 |
| — Endocarp without spines on dorsal face | 6 |
| 4. Spines with blunt extremities | 39. <i>Rhigiocarya</i> |
| — Acute spines | 5 |
| 5. Spines participating, at least partially, to condyle wall | 33. <i>Parabaena</i> |
| — Spines not participating to condyle wall | 24. <i>Kolobopetalum</i> |
| 6. Endocarp bearing wings | 7 |
| — Endocarp wingless | 8 |
| 7. Endocarp bearing two wings on each side | 26. <i>Leptoterantha</i> |
| — Endocarp bearing one wing on each side | 11. <i>Chasmanthera</i> |
| 8. Endocarp with some low-elevated longitudinal dorsal ridges | 49. <i>Syntriandrium</i> |
| — Endocarp with numerous short points on dorsal face | 40. <i>Sarcolophium</i> |
| 9. Endocarp without condyle | 10 |
| — Endocarp with condyle | 13 |
| 10. Endocarp dorsoventrally flattened | 53. <i>Tinomiscium</i> |
| — Endocarp cylindrical | 11 |

11. Endocarp surface almost smooth and with one ventral longitudinal groove 12
 — Endocarp with a network of small grooves on surface 31. *Orthomene*
12. Ventral groove ended by a hollow 44. *Sphenocentrum*
 — Ventral groove without a hollow 34. *Penianthus*
13. Condyle reduced to a longitudinal groove 20. *Fibraurea*
 — Condyle more or less spherical 14
14. Endocarp spiny 15
 — Endocarp without spines 18
15. Spines densely arranged 16
 — Spines not densely arranged 17
16. Short spines 17. *Dioscoreophyllum*
 — Long spines 8. *Burasaia*
17. Spines very scattered and very short, not blunt 9. *Calycocarpum*
 — Spines blunt 30. *Odontocarya* p.p.
18. Apical keel much developed 36. *Platytiñospora*
 — Apical keel lacking or little developed 19
19. Surface covered with fibres associated to mesocarp 23. *Jateorhiza*
 — Surface without numerous fibres associated to mesocarp 20
20. Endocarp with a dorsal ridge, even very short 21
 — Endocarp without any dorsal ridge 7. *Borismene*
21. Endocarp from Americas 30. *Odontocarya*
 — Endocarp from Africa or Asia 54. *Tinospora*
22. Endocarp horseshoe-shaped 23
 — Endocarp not horseshoe-shaped 44
23. Endocarp ring-shaped 50. *Syrrhonema*
 — Endocarp not ring-shaped 24
24. Seed cavity forming a spiral 25
 — Seed cavity not forming a spiral 26
25. Lateral ornamentation more or less reticulated 47. *Strychnopsis*
 — Lateral ornamentation not reticulated 45. *Spirospermum*
26. No excavated faces 27
 — Excavated faces 31
27. Endocarp with a large dorsal strip 27. *Limacia*
 — Endocarp without a large dorsal strip 28
28. Endocarp without lateral ridges 38. *Rhaptonema*
 — Endocarp with lateral ridges 29
29. Endocarp with numerous lateral ridges bearing spines 16. *Cyclea*
 — Endocarp with numerous lateral ridges without spines 30

30. Surface with reticulated ridges	21. <i>Hyperbaena</i> p.p.
— Rugose surface loosely organized	37. <i>Pycnarrhena</i> p.p.
31. Surface completely smooth	32
— Surface more or less irregular	33
32. Dorsal ridge continuous	25. <i>Legnephora</i>
— Dorsal ridge discontinuous	46. <i>Stephania</i> p.p.
33. Endocarp without lateral ridges	34
— Endocarp with lateral ridges	37
34. Central area completely opened	42. <i>Sciadotenia</i> p.p.
— Central area partially covered	35
35. Surface with numerous closed transverse ridges	32. <i>Pachygone</i> p.p.
— Surface with few closed transverse ridges	36
36. Limbs almost similar	22. <i>Hypserpa</i>
— Limbs different	14. <i>Cocculus</i> p.p.
37. Endocarp with one lateral ridge on each side	38
— Endocarp with two lateral ridges on each side	42
38. Central area completely surrounded	39
— Central area ventrally opened	40
39. Dorsal face with a double concavity	28. <i>Limaciopsis</i>
— Dorsal face convex	14. <i>Cocculus</i> p.p.
40. Strong ornamentation	46. <i>Stephania</i> p.p.
— Light ornamentation	41
41. Lateral ridges less than 25	43. <i>Sinomenium</i>
— Lateral ridges more than 26	29. <i>Menispermum</i>
42. Limbs coming closer, at least slightly	13. <i>Cissampelos</i>
— Limbs not coming closer	43
43. Short spines	41. <i>Sarcopetalum</i>
— Long spines	35. <i>Pericampylus</i>
44. Endocarp hairpin-shaped	45
— Endocarp not hairpin-shaped	62
45. Condyle inconspicuous or slightly conspicuous	46
— Condyle externally conspicuous	53
46. Surface scattered with small hollows	5. <i>Anomospermum</i>
— Surface without conspicuous hollows	47
47. Smooth surface	48
— Surface ornamented	49
48. One limb ending comma-shaped	1. <i>Abuta</i> p.p.
— Limbs parallel until extremities	4. <i>Anisocycla</i> p.p.

49. Surface bearing reticulated fibres	50
— Surface with a network of grooves	51
50. Limbs externally distinguishable	2. <i>Albertisia</i>
— Limbs not externally distinguishable	4. <i>Anisocycla</i> p.p.
51. Endocarp very large (more than 5 cm long)	19. <i>Elephantomene</i>
— Endocarp not very large	52
52. Grooves shallow	51. <i>Telitoxicum</i>
— Grooves deep	1. <i>Abuta</i> p.p.
53. Central area present, sometimes reduced	18. <i>Diploclisia</i>
— No central area	54
54. Both limbs equivalent	55
— One limb stronger than the other	61
55. Surface with grooves or reticulated fibres	56
— Surface without grooves or reticulated fibres	57
56. Surface covered with reticulated fibres	12. <i>Chondrodendron</i>
— Surface with several grooves	48. <i>Synclisia</i>
57. Limbs ending comma-shaped	58
— Limbs ending straight	59
58. Endocarp almost smooth with woody and stiff texture	10. <i>Carronia</i>
— Endocarp with crustaceous and brittle texture	52. <i>Tiliacora</i> p.p.
59. Endocarp with one longitudinal dorsal ridge	32. <i>Pachygone</i> p.p.
— Endocarp without a longitudinal ridge	52
60. Limbs slightly exceeding curved part	21. <i>Hyperbaena</i> p.p.
— Limbs conspicuously exceeding curved part	52. <i>Tiliacora</i> p.p.
61. Endocarp wall very thick	55. <i>Triclisia</i>
— Endocarp wall not very thick	21. <i>Hyperbaena</i> p.p.
62. Endocarp kidney-shaped	63
— Endocarp globose	66
63. Surface with grooves or alveoli	64
— Surface without grooves or alveoli	65
64. Surface with reticulated grooves	3. <i>Anamirta</i>
— Surface with small alveoli	42. <i>Sciadotenia</i> p.p.
65. Endocarp without condyle	37. <i>Pycnarrhena</i> p.p.
— Endocarp with condyle	32. <i>Pachygone</i> p.p.
66. Endocarp with numerous fibres associated to the mesocarp	6. <i>Arcangelisia</i>
— Endocarp without fibres associated to the mesocarp	67
67. Endocarp wall thick and stiff	15. <i>Coscinium</i>
— Endocarp wall thin and brittle	37. <i>Pycnarrhena</i> p.p.

SPECIES DESCRIPTIONS

1. Genus *Abuta* Barrère ex Aubl.

Abuta bullata Moldenke (Fig. 3A)

MATERIAL EXAMINED. — **Guyana**. Upper Demerara, Maruba Hill, *J. J. Pipoly 8964* (P).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; one dorsal groove, one lateral groove on each side; surface ornamented with numerous reticulated grooves; limbs straight ending parallel, one shorter, two lateral small hollows at their junction; condyle not visible externally. Length, 27.9 mm; width, 19.1 mm; thickness, 15.3 mm.

Abuta candollei Triana & Planch. (Fig. 3B)

MATERIAL EXAMINED. — **French Guiana**. Cayenne, *Soubirou s.n.* (P).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; one dorsal groove, one lateral groove on each side; smooth surface; one limb thinner and smaller than the other, the biggest one ending comma-shaped; condyle not visible outside. Length, 13.0 mm; width, 9.3 mm; thickness, 9.4 mm.

Abuta grandifolia (Mart.) Sandwith (Fig. 3C)

MATERIAL EXAMINED. — **Brazil**. Matto Grosso, *R. Souza 10426* (P).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; one dorsal groove, one lateral groove on each side; surface ornamented with reticulated grooves; limbs parallel and ending straight, one shorter; condyle not visible externally. Length, 15.2 mm; width, 11.6 mm; thickness, 9.7 mm.

Abuta imene (Mart.) Eichler (Fig. 3D)

MATERIAL EXAMINED. — **Brazil**. *Campbell et al. 22412* (U).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; one dorsal groove, one lateral groove on each side; surface with shallow reticulated grooves; one limb slightly thinner than the other; condyle not visible externally. Length, 15.6 mm; width, 11.2 mm; thickness, 9.6 mm.

Abuta rufescens Aubl. (Fig. 3E)

MATERIAL EXAMINED. — **Brazil**. Amazonas, Manaus, *B. A. Krukoff 8030* (P).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; one dorsal groove, one lateral groove on each side; surface ornamented with numerous reticulated grooves; limbs parallel and ending straight, one shorter; condyle invisible externally. Length, 22.7 mm; width, 12.8 mm; thickness, 10.7 mm.

2. Genus *Albertisia* Becc.

Albertisia mangenotii (Guillaumet & Debray) Forman (Fig. 3F)

MATERIAL EXAMINED. — **Ivory Coast**. Between Boubélé and Olodio, *J.-L. Guillaumet 793* (P).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; no ridges; surface ornamented with reticulated fibres; limbs slightly distinguishable, one thinner; condyle not visible externally, reduced internally to a small lameliform invagination; inner surface smooth. Length, 15.2 mm; width, 10.1 mm; thickness, 9.0 mm.

3. Genus *Anamirta* Colebr.

Anamirta cocculus (L.) Wight & Arn. (Fig. 4A)

MATERIAL EXAMINED. — **Vietnam**. Nam Ky, Bassac, *Thorel s.n.* (P).

DESCRIPTION

Endocarp reniform, rounded in outline; no ridges; surface with reticulated grooves; one extremity pointed more inwards; globular internal condyle

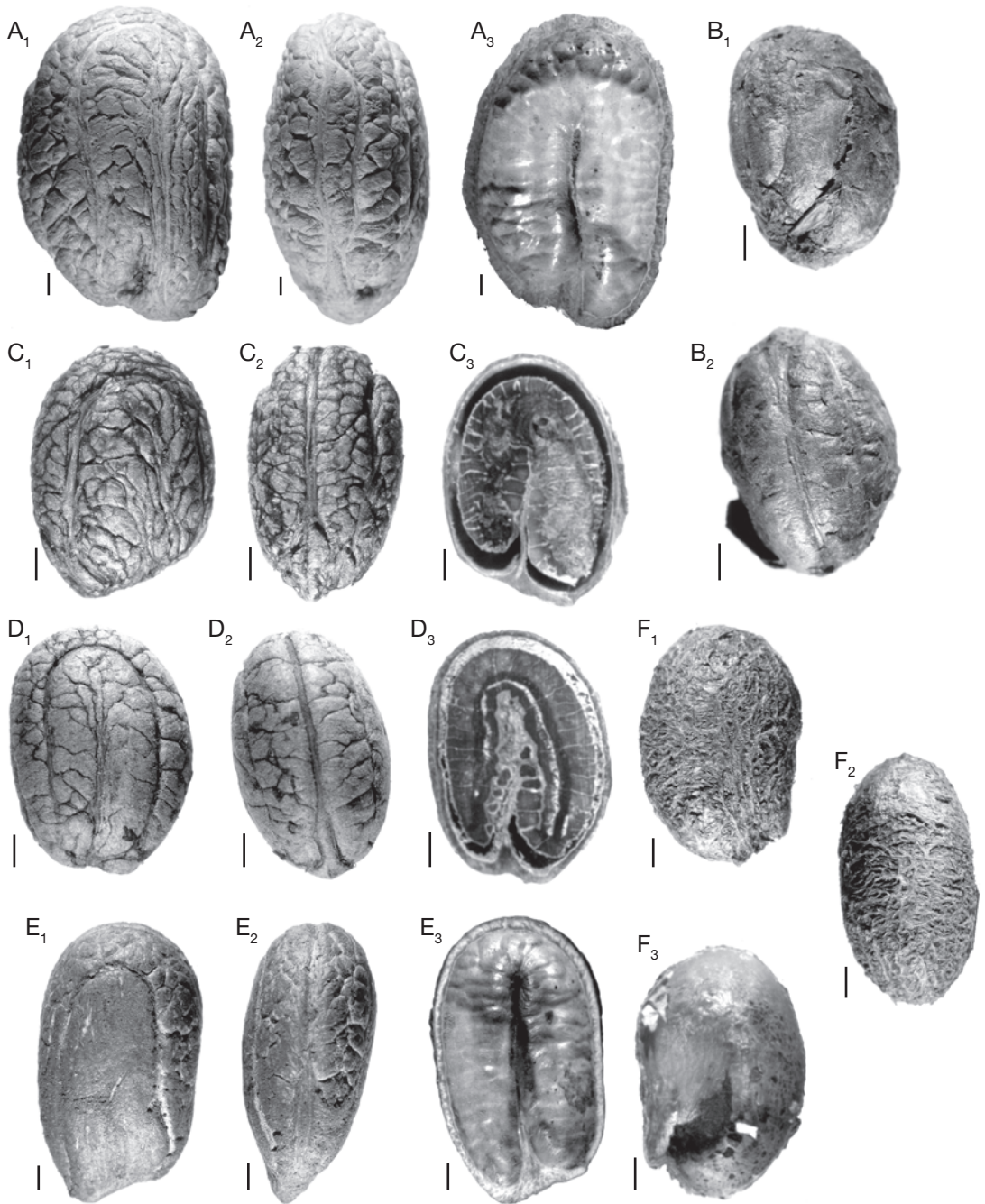


FIG. 3. — Endocarps of Menispermaceae: **A**, *Abuta bullata* Moldenke, *J. J. Pipoly 8964*; **A**₁, lateral view; **A**₂, dorsal view; **A**₃, sagittal section; **B**, *Abuta candollei* Triana & Planch., *Soubirou s.n.*; **B**₁, lateral view; **B**₂, dorsal view; **C**, *Abuta grandifolia* (Mart.) Sandwith, *R. Souza 10426*; **C**₁, lateral view; **C**₂, dorsal view; **C**₃, sagittal section; **D**, *Abuta imene* (Mart.) Eichler, *Campbell 22412*; **D**₁, lateral view; **D**₂, dorsal view; **D**₃, sagittal view; **E**, *Abuta rufescens* Aubl., *B. A. Krukoff 8030*; **E**₁, lateral view; **E**₂, dorsal view; **E**₃, sagittal section; **F**, *Albertisia mangentii* (Guillaumet & Debray) Forman, *J.-L. Guillaumet 793*; **F**₁, lateral view; **F**₂, dorsal view; **F**₃, sagittal section. Scale bars: 2 mm.

in two chambers, connected to the exterior by two small ventral hollows. Length, 10.1 mm; width, 8.6 mm; thickness, 7.9 mm.

4. Genus *Anisocycla* Baill.
Anisocycla jollyana (Pierre) Diels
(Fig. 4B)

MATERIAL EXAMINED. — **Gabon**. Libreville, *Klaine 2581* (P).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; no ridges; surface ornamented with reticulated fibres; limbs fused; condyle not visible externally. Length, 14.8 mm; width, 8.7 mm; thickness, 8.7 mm.

Anisocycla linearis Pierre ex Diels
(Fig. 4C)

MATERIAL EXAMINED. — **Madagascar**. Maevatanana, *H. Perrier de la Bâthie 250* (P).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; no ridges; surface rugose; limbs ending parallel and of same length; double intrusive lateral condyle very thin. Length, 11.8 mm; width, 9.4 mm; thickness, 8.1 mm.

5. Genus *Anomospermum* Miers
Anomospermum steyermarkii
Krukoff & Barneby
(Fig. 4D)

MATERIAL EXAMINED. — **Brazil**. *Prance et al. 10809* (U).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; one slight dorsal ridge; surface reticulation delimiting lines of deep hollows; one limb thinner and shorter than the other, the largest one bent backwards at its extremity; a shallow depression at the endocarp fold level. Length, 33 mm; width, 21.8 mm; thickness, 19.5 mm.

6. Genus *Arcangelisia* Becc.
Arcangelisia flava (L.) Merr.
(Fig. 4E)

MATERIAL EXAMINED. — **Malaysia**. Sarawak, *James et al. S 35063* (L).

DESCRIPTION

Subglobular endocarp; one dorsal ridge; surface densely covered with fibrous hairs; no condyle. Length, 26.3 mm; width, 20.7 mm; thickness, 17.9 mm.

7. Genus *Borismene* Barneby
Borismene japurensis (Mart.) Barneby
(Fig. 4H)

MATERIAL EXAMINED. — Unknown origin, *F. J. Breteler 3856* (U).

DESCRIPTION.

Endocarp straight, elliptic in outline with a ventral condyle; no ridges; surface smooth; obtuse at base and apex; intrusive ventral condyle forming a longitudinal groove 9.0 mm long and 0.7 mm wide. Length, 14.6 mm; width, 11.4 mm; thickness, 10.6 mm.

8. Genus *Burasaia* Thou.

Burasaia sp.
(Fig. 4F)

MATERIAL EXAMINED. — **Madagascar**. Toamasina, Farankairana, *G. E. Schatz 3834A* (P). — Antsiranana, Ambatosoratra, *J. S. Miller 4205* (P).

DESCRIPTION

Endocarp straight, elliptic in outline with a ventral condyle; no ridges; not keeled; surface densely covered with thin and long spines; simple intrusive condyle without protruding chamber, moderate and elliptic aperture 9.0 mm long and 1.5 mm wide. Length, 19.7-22.2 mm; width, 12.0-13.5 mm; thickness, 10.8-12.0 mm.

9. Genus *Calycocarpum* Nutt. ex Torr. & Gray
Calycocarpum lyonii (Pursh) Nutt. ex A. Gray
(Fig. 4G)

MATERIAL EXAMINED. — **United States of America**. Florida, Chattoohoochee, *A. H. Curtis 5934* (P).

DESCRIPTION

Endocarp straight, rounded in outline with a ventral condyle; one shallow dorsal ridge; surface with

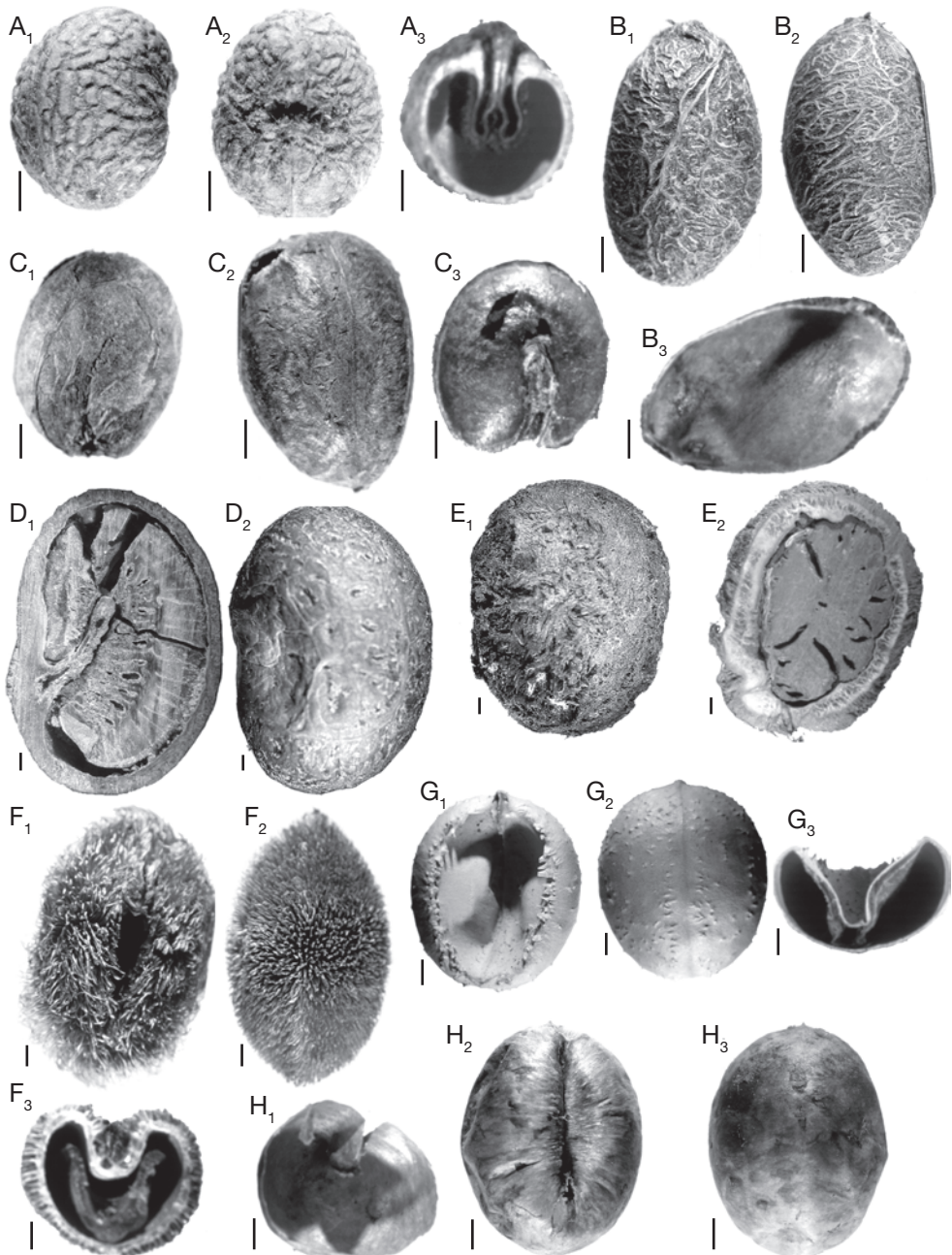


FIG. 4. — Endocarps of Menispermaceae: **A**, *Anamirta cocculus* (L.) Wight & Arn., *Thorel s.n.*; **A**₁, dorsal view; **A**₂, ventral view; **A**₃, transverse section; **B**, *Anisocycla jollyana* (Pierre) Diels, *Klaine 2581*; **B**₁, lateral view; **B**₂, dorsal view; **B**₃, sagittal section; **C**, *Anisocycla linearis* Pierre ex Diels, *H. Perrier de la Bâthie 250*; **C**₁, lateral view; **C**₂, dorsal view; **C**₃, sagittal section; **D**, *Anomospermum steyermarkii* Krukoff & Barneby, *Prance et al. 10809*; **D**₁, sagittal section; **D**₂, lateral view; **E**, *Arcangelisia flava* (L.) Merr., *James et al. S35063*; **E**₁, lateral view; **E**₂, sagittal section; **F**, *Burasia* sp.; **F**₁, ventral view, *J. S. Miller 4205*; **F**₂, **F**₃, *Schatz 3834A*; **F**₂, dorsal view; **F**₃, transverse section; **G**, *Calycocarpum lyonii* (Pursh) Nutt. ex A. Gray, *A. H. Curtis 5934*; **G**₁, ventral view; **G**₂, dorsal view; **G**₃, transverse section; **H**, *Borismene japurensis* (Mart.) Barneby, *F. J. Breteler 3856*; **H**₁, transverse section; **H**₂, ventral view; **H**₃, dorsal view. Scale bars: 2 mm.

scattered small points; large intrusive condyle corresponding to the whole ventral face, delimited by a spiny line, and separated in two parts by a ventral ridge. Length, 16.5 mm; width, 14.1 mm; thickness, 9.0 mm.

10. Genus *Carronia* F.Muell.

Carronia thyrsoiflora (Becc.) Diels
(Fig. 6A)

MATERIAL EXAMINED. — **Papua-New Guinea**. Morobe, Lae, *H. Streitmann* & *A. Kairo* 47719 (L).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; one dorsal ridge, no lateral ridges; rugose surface; the two limbs ending comma-shaped, of same length; double intrusive lateral condyle. Length, 15.0 mm; width, 9.6 mm; thickness, 7.0 mm.

11. Genus *Chasmanthera* Hochst.

Chasmanthera dependens Hochst.
(Fig. 5A)

MATERIAL EXAMINED. — **Cameroon**. NKamba, Baji-Tumbo, *R. Letouzey* 14028 (P).

Central African Republic. Oubangui, Boukoko, *C. Tisserant* 962 (P).

DESCRIPTION

Endocarp straight, elliptic in outline with a ventral condyle; one short dorsal ridge, one lateral wing on each side borne by the dorsal face; keeled at apex, obtuse at base, smooth surface; simple intrusive ventral condyle developed in protruding ventral chamber, small elliptic aperture 5.0-6.0 mm long and 1.0-2.0 mm wide. Length, 13.1-13.5 mm; width, 9.8-11.4 mm; thickness, 6.5-7.9 mm.

12. Genus *Chondrodendron* Ruiz & Pav.

Chondrodendron platyphyllum (A.St.-Hil.) Diels
(Fig. 5B)

MATERIAL EXAMINED. — **Brazil**. Catumby, *Nadeaud s.n.* (P).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; one dorsal ridge; surface ornamented with reticulated

fibres; limbs ending parallel, of same length; double intrusive lateral condyle very thin. Length, 10.8 mm; width, 8.2 mm; thickness, 6.8 mm.

13. Genus *Cissampelos* L.

Cissampelos fasciculata Benth.
(Fig. 5C)

MATERIAL EXAMINED. — **French Guiana**. *Oldeman* 545 (P).

DESCRIPTION

Endocarp horseshoe-shaped, elliptic in outline with flat faces; two dorsal ridges, two lateral ridges on each side (the outer one partly overlapping the inner one), all ridges bearing about 12 small spines; dorsal face with two lateral concavities; smooth surface; the two limbs ending at the same level and parallel but quite further than the central area; double external condyle inconspicuous, not perforated. Length, 6.8 mm; width, 5.8 mm; thickness, 2.7 mm.

Cissampelos mucronata A.Rich.
(Fig. 5D)

MATERIAL EXAMINED. — **Burkina Faso**. Tandéba, *J. C. Bille* 3059 (P).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with excavated faces; two dorsal ridges, two lateral ridges on each side (the outer one partly overlapping the inner one), all ridges bearing outgrowths; dorsal face with two lateral concavities; smooth surface; one limb longer than the other, limbs ending parallel; double external condyle, not perforated. Length, 4.4 mm; width, 3.9 mm; thickness, 2.2 mm.

Cissampelos owariensis P.Beauv. ex DC.
(Fig. 5E)

MATERIAL EXAMINED. — **Democratic Republic of the Congo**. Kotili, *W. Robyns* 1153 (P).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; two dorsal ridges with small spines pointing laterally, two lateral ridges on each side (the outer one partly overlapping the inner one) with the same small spines;

smooth surface; one limb longer than the other; double external condyle, not perforated. Length, 4.5 mm; width, 2.8 mm; thickness, 2.1 mm.

Cissampelos pareira L.
(Fig. 5F)

MATERIAL EXAMINED. — Mexico. Orizaba, Bourgeau 244 (P).
Laos. L. Prabang, Pac Bac, E. Poilane 20540 (P).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with slightly excavated faces; two dorsal ridges, two lateral ridges on each side (the outer one partly overlapping the inner one), all ridges bearing outgrowths; dorsal face with two lateral concavities; smooth surface; one limb longer than the other, limbs ending parallel; double external condyle, not perforated. Length, 4.4-4.7 mm; width, 3.9 mm; thickness, 1.8-2.1 mm.

14. Genus *Cocculus* DC.

Cocculus carolinus (L.) DC.
(Fig. 5G)

MATERIAL EXAMINED. — United States of America. Missouri, Taney, E. J. Palmer 22109 (P).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with excavated faces; one dorsal groove, one lateral groove on each side, numerous reticulated transverse ridges; dorsal face convex; one limb ending outwards, the other inwards; double external condyle, not perforated; central area small and comma-like, completely closed. Length, 5.0 mm; width, 4.1 mm; thickness, 2.1 mm.

Cocculus hirsutus (L.) W.Theob.
(Fig. 5H)

MATERIAL EXAMINED. — Unknown origin, Boy Joana 7478 (Reid collection, BM).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with excavated faces; one dorsal ridge, one lateral ridge on each side, about 18 transverse and reticu-

lated ridges; dorsal face convex; one limb ending more outwards than the other; double external condyle, perforated; central area very small and completely closed.

Cocculus laurifolius DC.
(Fig. 5J)

MATERIAL EXAMINED. — Unknown origin, collector unknown (Reid collection, BM).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with excavated faces; one slight dorsal groove, one lateral ridge on each side, about 18 transverse and reticulated low ridges; dorsal face convex; one limb ending more outwards than the other; double external condyle, not perforated; central area very small and completely closed.

Cocculus orbiculatus (L.) DC.
(Fig. 5I)

MATERIAL EXAMINED. — China. Yunnan, J. Cavalerie 984 (P).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with excavated faces; one dorsal groove, one lateral ridge on each side, about 18 transverse and reticulated ridges; dorsal face convex; one limb ending more outwards than the other; double external condyle, not perforated; central area very small and completely closed. Length, 5.1 mm; width, 5.2 mm; thickness, 3.0 mm.

Cocculus pendulus (J.R.Forst. & G.Forst.) Diels
(Fig. 5K)

MATERIAL EXAMINED. — Pakistan. Baluchistan, D. De Franceschi 70 (P, sheet communicated by D. De Franceschi).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with excavated faces; one slight dorsal ridge, no lateral ridges; rugose surface irregular; dorsal face convex; double external condyle, not perforated, a strip partly hiding it ventrally. Length, 3.2 mm; width, 3.8 mm; thickness, 2.0 mm.

15. Genus *Coscinium* Colebr.

Coscinium fenestratum Colebr.
(Fig. 5L)

MATERIAL EXAMINED. — Vietnam. Kontum, *E. Poilane* 35641 (P).

DESCRIPTION

Globular endocarp; no ridges; smooth surface; two small ventral-lateral holes. These holes are connected with two internal chambers. Diameter, 18.7 mm.

16. Genus *Cyclea* Arn. ex Wight

Cyclea barbata Miers
(Fig. 6B)

MATERIAL EXAMINED. — Vietnam. Nam Ky, *L. Pierre* 1261 (P).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline without excavated faces, two dorsal ridges bearing about 16 small spines, two lateral ridges on each side (the outer one partly overlapping the inner one), the outer one only bearing small spines; dorsal face convex; smooth surface; double external condyle inconspicuous. Length, 4.8 mm; width, 4.0 mm; thickness, 2.7 mm.

Cyclea hypoglauca (Schauer) Diels
(not illustrated)

MATERIAL EXAMINED. — China. Hong-Kong, *K. Y. Chan* 1144 (P).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline without excavated faces; two dorsal ridges bearing about 16 small spines, two lateral ridges on each side (the outer one partly overlapping the inner one), the outer one only bearing small spines; dorsal face convex; smooth surface; double external condyle inconspicuous. Length, 3.5 mm; width, 3.3 mm; thickness, 2.3 mm.

17. Genus *Dioscoreophyllum* Engl.

Dioscoreophyllum cumminsii (Stapf) Diels
(Fig. 6C)

MATERIAL EXAMINED. — Central African Republic. Oubangui, Boukoko, *C. Tisserant* 608 (P).

DESCRIPTION

Endocarp straight rounded, in outline with ventral chamber; one dorsal ridge only at apex, no lateral ridges; keeled at apex, obtuse at base; surface covered with strong and short spines arranged in circles centred on the condyle aperture; simple intrusive condyle without protruding chamber, with a small circular aperture 0.8 mm long and 0.6 mm wide. Length, 6.8 mm; width, 5.6 mm; thickness, 4.4 mm.

18. Genus *Diploclisia* Miers

Diploclisia affinis (Oliv.) Diels
(Fig. 6E)

MATERIAL EXAMINED. — Unknown origin, *FMW2286* (Reid collection, BM).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; one dorsal ridge, one lateral ridge on each side, connected by about 30 transverse ridges; double intrusive lateral condyle not perforated, large central area; the transverse ridges impressed on inner surface. Length, 4.4 mm; width, 3.0 mm; thickness, 2.0 mm.

Diploclisia glaucescens (Blume) Diels
(Fig. 6D)

MATERIAL EXAMINED. — Vietnam. Tourane, *E. Poilane* 7640 (P).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; one dorsal ridge, one lateral ridge, with a groove on its top, on each side, connected by about 31 transverse ridges; double intrusive lateral condyle not perforated, small central area; the transverse ridges impressed on inner surface. Length, 18.8 mm; width, 9.3 mm; thickness, 5.9 mm.

19. Genus *Elephantomene* Barneby & Krukoff

Elephantomene eburnea Barneby & Krukoff
(Fig. 6H)

MATERIAL EXAMINED. — French Guiana. La Fumée, *S. A. Mori et al.* 18586 (P).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; no

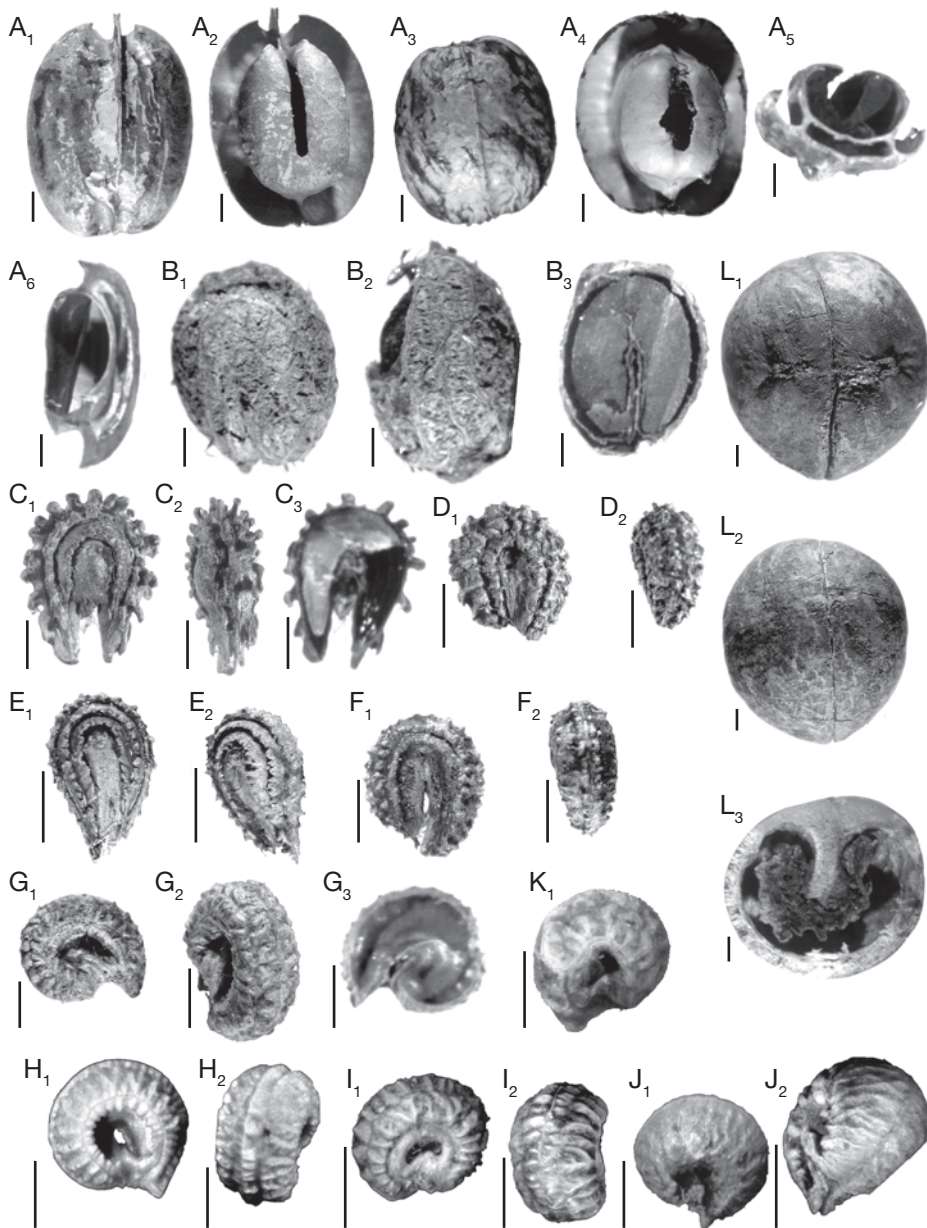


FIG. 5. — Endocarps of Menispermaceae: **A**, *Chasmanthera dependens* Hochst.; **A**₁, **A**₂, *C. Tisserant* 962; **A**₁, dorsal view; **A**₂, ventral view; **A**₃, **A**₄, *Letouzey* 14028; **A**₃, dorsal view; **A**₄, ventral view; **A**₅, **A**₆, *C. Tisserant* 962; **A**₅, transverse section; **A**₆, sagittal section; **B**, *Chondrodendron platyphyllum* (A.St.-Hill.) Diels, *Nadeaud* s.n.; **B**₁, lateral view; **B**₂, dorsal view; **B**₃, sagittal section; **C**, *Cissampelos fasciculata* Benth., *Oldeman* 545; **C**₁, lateral view; **C**₂, dorsal view; **C**₃, sagittal section; **D**, *Cissampelos mucronata* A.Rich., *J. C. Bille* 3059; **D**₁, lateral view; **D**₂, dorsal view; **E**, *Cissampelos owariensis* P.Beauv. ex DC., *W. Robyns* 1153; **E**₁, lateral view; **E**₂, semi-dorsal view; **F**, *Cissampelos pareira* L., *E. Poilane* 20540; **F**₁, lateral view; **F**₂, dorsal view; **G**, *Cocculus carolinus* (L.) DC., *E. J. Palmer* 22109; **G**₁, lateral view; **G**₂, dorsal view; **G**₃, sagittal section; **H**, *Cocculus hirsutus* (L.) W.Theob., *Boy Joana* 7478; **H**₁, lateral view; **H**₂, dorsal view; **I**, *Cocculus orbiculatus* (L.) DC., Reid collection; **I**₁, lateral view; **I**₂, dorsal view; **J**, *Cocculus laurifolius* DC., Reid collection; **J**₁, lateral view; **J**₂, dorsal view; **K**, *Cocculus pendulus* (J.R.Forst. & G.Forst.) Diels, *D. De Franceschi* 70; **K**₁, lateral view; **L**, *Cosciniium fenestratum* Colebr., *E. Poilane* 35641; **L**₁, ventral view; **L**₂, dorsal view; **L**₃, sagittal section. Scale bars: 2 mm.

ridges; surface ornamented with reticulated grooves; limbs ending parallel, one shorter; condyle not visible externally. Length, 59 mm; width, 23.4 mm; thickness, 21.8 mm.

20. Genus *Fibraurea* Lour.

Fibraurea recisa Pierre
(Fig. 6F)

MATERIAL EXAMINED. — Vietnam. *E. Poilane* 23492 (P).

DESCRIPTION

Endocarp straight, elliptic in outline without condyle; one dorsal ridge, one ventral shallow groove ending sometimes into a hole at one end; smooth surface. Length, 23.0 mm; width, 12.6 mm; thickness, 11.0 mm.

Fibraurea tinctoria Lour.
(Fig. 6G)

MATERIAL EXAMINED. — Thailand. Songla, *K. Larsen et al.* 42660 (P).

DESCRIPTION

Endocarp straight, elliptic in outline without condyle; no ridges, one ventral shallow groove; thin surface. Length, 21.6 mm; width, 13.5 mm; thickness, 11.7 mm.

21. Genus *Hyperbaena* Miers ex Benth.

Hyperbaena axilliflora (Griseb.) Urb.
(Fig. 6I)

MATERIAL EXAMINED. — Cuba. Pinard el Rio, *Leon* 4376 (P).

DESCRIPTION

Endocarp hairpin-shaped, rounded in outline; one slight dorsal ridge, two slight lateral ridges on each side; surface reticulate; limbs ending parallel and pointed, of same length; double intrusive lateral condyle comma-shaped. Length, 12.0 mm; width, 10.9 mm; thickness, 8.2 mm.

Hyperbaena cubensis (Griseb.) Urb.
(Fig. 6J)

MATERIAL EXAMINED. — Cuba. Oriente, *C. Wright* 1853 (P).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline without excavated faces; one slight dorsal ridge, two slight lateral ridges on each side; surface reticulate; one limb ending inwards the other outwards; double intrusive lateral condyle. Length, 9.6 mm; width, 8.2 mm; thickness, 6.8 mm.

Hyperbaena domingensis (DC.) Benth.
(Fig. 7A)

MATERIAL EXAMINED. — Guadeloupe. *Stehlé* 297 (P).
Martinique. *Plée s.n.* (P).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; one inconspicuous dorsal ridge, no lateral ridges; surface ornamented with small transverse and reticulated ridges; limbs ending straight, one thinner than the other; double intrusive lateral and lamelliform condyle; inner surface smooth. Length, 13.6-14.7 mm; width, 9.2-10.9 mm; thickness, 7.2-8.4 mm.

Hyperbaena laurifolia (Poir.) Urb.
(Fig. 7B)

MATERIAL EXAMINED. — Porto Rico. *L. C. Richard s.n.* (P).

DESCRIPTION

Endocarp hairpin-shaped, rounded in outline; one dorsal ridge, two lateral ridges on each side; surface reticulated; limbs short and ending straight; double intrusive lateral condyle. Length, 22.1 mm; width, 22.1 mm; thickness, 13.7 mm.

22. Genus *Hypserpa* Miers

Hypserpa nitida Miers ex Benth.
(Fig. 7C)

MATERIAL EXAMINED. — Vietnam. Cia Bang, *H. Bon* 55665 (P).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with excavated faces; one slight dorsal ridge, no lateral ridges; surface reticulate; dorsal face convex; the two limbs of same length; double external condyle partly filled. Length, 6.5 mm; width, 6.5 mm; thickness, 4.1 mm.



FIG. 6. — Endocarps of Menispermaceae: **A**, *Carronia thyrsiflora* (Becc.) Diels, *H. Streitmann & A. Kairo* 47719; **A**₁, lateral view; **A**₂, dorsal view; **A**₃, sagittal view; **B**, *Cyclea barbata* Miers, *L. Pierre* 1261; **B**₁, lateral view; **B**₂, semi-dorsal view; **C**, *Dioscoreophyllum cumminsii* (Stapf) Diels, *C. Tisserant* 608; **C**₁, dorsal view; **C**₂, semi-ventral view; **C**₃, sagittal section; **D**, *Diploclesia glaucescens* (Blume) Diels, *E. Poilane* 7640; **D**₁, sagittal section; **D**₂, dorsal view; **D**₃, lateral view; **E**, *Diploclesia affinis* (Oliv.) Diels, *FMW*2286; **E**₁, lateral view; **F**, *Fibraurea recisa* Pierre, *E. Poilane* 23492; **F**₁, dorsal view; **F**₂, ventral view; **F**₃, transverse section; **G**, *Fibraurea tinctoria* Lour., *K. Larsen et al.* 42660; **G**₁, transverse section; **G**₂, dorsal view; **G**₃, ventral view; **H**, *Elephantomene eburnea* Barneby & Krukoff, *S. A. Mori et al.* 18586; **H**₁, lateral view; **H**₂, dorsal view; **I**, *Hyperbaena axilliflora* (Griseb.) Urb., *Leon* 4376; **I**₁, lateral view; **I**₂, dorsal view; **I**₃, sagittal section; **J**, *Hyperbaena cubensis* (Griseb.) Urb., *Wright* 1853; **J**₁, lateral view; **J**₂, dorsal view; **J**₃, sagittal section. Scale bars: A-G, I, J, 2 mm; H, 4 mm.

23. Genus *Jateorbiza* Miers

Jateorbiza macrantha (Hook.f.) Exell & Mendonça
(Fig. 7D)

MATERIAL EXAMINED. — **Gabon**. Libreville, *Klaine 154* (P).

Cameroon. *F. J. Breteler 623* (P). — *Verdcourt 1905A* (Reid collection, BM).

DESCRIPTION

Endocarp straight, elliptic in outline with a ventral condyle; one dorsal ridge particularly conspicuous at apex, no lateral ridges; slightly keeled at apex and base; surface covered with buboes and slender fibers that colonize the pulpy mesocarp, these fibers absent in the condyle; simple intrusive condyle without protruding chamber, a ventral ridge dividing it in two parts, broad and elliptic aperture 5.5-7.0 mm long and 4.3-4.8 mm wide. Length, 15.2-17.4 mm; width, 10.0-10.4 mm; thickness, 7.5-8.3 mm.

24. Genus *Kolobopetalum* Engl.

Kolobopetalum auriculatum Engl.
(Fig. 7E)

MATERIAL EXAMINED. — **Cameroon**. Ndikiniméki, Bandounga, *R. Letouzey 11196* (P).

DESCRIPTION

Endocarp straight, rounded in outline with ventral condyle; no ridges; obtuse at base and apex; surface densely covered with long spines; simple intrusive condyle developed in protruding ventral chamber, aperture almost circular 2.0 mm long and 1.0 mm wide. Length, 9.9 mm; width, 8.5 mm; thickness, 6.0 mm.

Kolobopetalum chevalieri
(Hutch. & Dalziel) Troupin
(Fig. 7F)

MATERIAL EXAMINED. — **Central African Republic**. Oubangui, Boukoko, *C. Tisserant 1020* (P).
Liberia. Yéképa, Nimba, *J. G. Adam 25723* (P).

DESCRIPTION

Endocarp straight, rounded to elliptic in outline with ventral condyle; one dorsal ridge, one lateral ridge on each side sometimes only apically; keeled at apex, obtuse at base; dorsal surface densely covered

with long spines; simple intrusive condyle developed in protruding ventral chamber, large to moderate aperture 3.5-5.0 mm long and 4.0-6.0 mm wide. Length, 12.2-14.0 mm; width, 8.5-10.5 mm; thickness, 6.2-8.7 mm.

Kolobopetalum ovatum Stapf
(Fig. 7G)

MATERIAL EXAMINED. — **Liberia**. Voinjama, Zorzor, *Jansen 2063* (P).

DESCRIPTION

Endocarp straight, elliptic in outline with ventral condyle; one dorsal ridge at apex, one lateral wing on each side; keeled at apex and slightly so at base; dorsal surface densely covered with long spines; simple intrusive ventral condyle developed in protruding ventral chamber, large circular aperture 4.5 mm long and 5.0 mm wide. Length, 12.3 mm; width, 8.8 mm; thickness, 5.5 mm.

25. Genus *Legnephora* Miers

Legnephora microcarpa Forman
(Fig. 7H)

MATERIAL EXAMINED. — **Papua-New Guinea**. Morobe, Balolo, *H. Streimann & A. Kairo 21169* (L).

DESCRIPTION

Endocarp horseshoe-shaped, elliptic in outline with excavated faces; one dorsal longitudinal and small strip, one lateral high strip on each side; smooth surface; dorsal face with two lateral concavities; double external concavities, not perforated, small central area. Length, 4.9 mm; width, 4.3 mm; thickness, 6.0 mm.

Legnephora minutiflora (K.Schum.) Diels
(Fig. 7I)

MATERIAL EXAMINED. — **Papua-New Guinea**. Morobe, Boana, *M. S. Clemens 8682* (L).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with excavated faces; one dorsal longitudinal and high strip (4.7 mm high), one lateral strip (4.1 mm high) on each side; smooth surface; dorsal face with

two lateral concavities; double external condyle, not perforated, large central area. Length, 14.5 mm; width, 12.5 mm; thickness, 10.5 mm.

26. Genus *Leptoterantha* Louis ex Troupin

Leptoterantha mayumbensis (Exell) Troupin
(Fig. 8A)

MATERIAL EXAMINED. — **Central African Republic.** Oubangui, Boukoko, *C. Tisserant 1099* (P).

DESCRIPTION

Endocarp straight, elliptic in outline with ventral condyle; one dorsal ridge, two lateral wings on each side borne by the dorsal face, the inner one wider; keeled at apex and base; smooth surface; simple intrusive ventral condyle developed in protruding ventral chamber, small circular aperture 2.5 mm long and 1.5 mm wide. Length, 12.5 mm; width, 9.2 mm; thickness, 7.2 mm.

27. Genus *Limacia* Lour.

Limacia scandens Lour.
(Fig. 8B)

MATERIAL EXAMINED. — **Vietnam.** Nam Ky, Songla, *L. Pierre 1643* (P).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline without excavated faces; one large dorsal band (8.0 mm wide) with rugose surface partly overlapping the lateral faces; smooth surface; condyle made of two large lateral cavities opened ventrally. Length, 20.4 mm; width, 15.45 mm; thickness, 12.3 mm.

28. Genus *Limaciopsis* Engl.

Limaciopsis loangensis Engl.
(Fig. 8C)

MATERIAL EXAMINED. — **Cameroon.** Yokadouma, *R. Letouzey 12245* (P).
Central African Republic. Oubangui, Boukoko, *C. Tisserant 1426* (P).

DESCRIPTION

Endocarp horseshoe-shaped, elliptic in outline with excavated faces; one dorsal ridge, one lateral ridge on each side, with small transverse ridges;

dorsal face with two lateral concavities; smooth surface; extremity of limbs ending inwards; double external condyle, not perforated; central area completely closed. Length, 14.2-15.9 mm; width, 11.5-11.8 mm; thickness, 5.2-6.2 mm.

29. Genus *Menispermum* L.

Menispermum canadense L.
(Fig. 8D)

MATERIAL EXAMINED. — **United States of America.** *Michaux s.n.* (P).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with excavated faces; one dorsal ridge, one lateral ridge on each side; smooth surface; dorsal face with two lateral concavities; one limb ending more inwards than the other; double external condyle, not perforated, making a large central area with a small hollow near one limb. Length, 7.1 mm; width, 6.7 mm; thickness, 2.1 mm.

Menispermum dauricum DC.
(Fig. 8E)

MATERIAL EXAMINED. — Unknown origin, collector unknown (Reid collection, BM).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with excavated faces; one dorsal ridge, one lateral ridge on each side; smooth surface with short spines on dorsal and ventral ridges; dorsal face with two lateral concavities; one limb ending more inwards than the other; double external condyle, not perforated, making a large central area with a conspicuous hollow near one limb. Length, 7.5 mm; width, 6.2 mm.

Menispermum diversifolium (Miq.) Gagnep.
(Fig. 8F)

MATERIAL EXAMINED. — **China.** *A. Henry 2509* (P).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with excavated faces; one dorsal ridge, one lateral ridge on each side, connected by short transverse

ridges; dorsal face with two lateral concavities; smooth surface; one limb ending more inwards than the other; double external condyle, not perforated, large central area with a small hollow near the longer limb. Length, 6.0 mm; width, 5.0 mm; thickness, 1.9 mm.

30. Genus *Odontocarya* Miers

Odontocarya echinus Barneby
(Fig. 8G)

MATERIAL EXAMINED. — Peru. Junin, Huatsiroke, F. Woytkowski 5546 (P).

DESCRIPTION

Endocarp straight, elliptic in outline with a ventral condyle; one dorsal ridge particularly conspicuous at the apex; keeled at apex, obtuse at base; surface covered with spines blunt at their extremity; simple intrusive condyle without protruding chamber, moderate elliptic aperture 4.0 mm long and 2.4 mm wide. Length, 10.4 mm; width, 7.0 mm; thickness, 4.9 mm.

Odontocarya wulschlaegelii (Eichler) Barneby
(Fig. 8H)

MATERIAL EXAMINED. — Unknown origin, L. C. Richard s.n. (P).

DESCRIPTION

Endocarp straight, elliptic in outline with a ventral condyle; one dorsal ridge and five slightly conspicuous lateral ridges; keeled at base and strongly so at apex; rugose surface; simple intrusive condyle without protruding chamber, moderate and elliptic aperture 4.3 mm long and 1.5 mm wide. Length, 12.0 mm; width, 6.6 mm; thickness, 5.4 mm.

Odontocarya sp.
(not illustrated)

MATERIAL EXAMINED. — Unknown origin, G. T. Prance et al. 2933 (U).

DESCRIPTION

Endocarp straight, elliptic in outline with a ventral condyle; one dorsal ridge, no lateral ridges; slightly keeled at apex and obtuse at base; rugose surface with

shallow points near base and apex; simple intrusive condyle without protruding chamber, small compound aperture 3.5 mm long and 2.0 mm wide. Length, 10.5 mm; width, 7.6 mm; thickness, 6.5 mm.

31. Genus *Orthomene* Barneby & Krukoff

Orthomene schomburgkii
(Miers) Barneby & Krukoff
(Fig. 8I)

MATERIAL EXAMINED. — Brazil. Amapa, Igarapé do Lago, R. L. Froes 27519 (P). — Para, Rio Trombates, G. T. Prance et al. 22251 (P).

DESCRIPTION

Endocarp straight, elliptic in outline without condyle; no ridges; surface ornamented with little deep and reticulated grooves. Length, 23.1-23.2 mm; width, 10.0-11.1 mm; thickness, 8.6-10.2 mm.

32. Genus *Pachygone*

Miers ex Hook.f. & T. Thomson

Pachygone dasycarpa Kurz
(Fig. 8J)

MATERIAL EXAMINED. — Cambodia. Kg. Thom, E. Poilane 14876 (P).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; one dorsal groove; rugose surface; limbs parallel; condyle inconspicuous externally. Length, 14.6 mm; width, 9.7 mm; thickness, 7.6 mm.

Pachygone nitida Pierre ex Gagnep.
(Fig. 9A)

MATERIAL EXAMINED. — Mekong river. Thorel 2104 (P).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with partly excavated faces; no ridges; surface reticulate; dorsal face convex; double external condyle not perforated, a strip partly hiding it ventrally. Length, 9.6 mm; width, 9.4 mm; thickness, 4.5 mm.

Pachygone odorifera Miers
(Fig. 9B)

MATERIAL EXAMINED. — Vietnam. E. Poilane 4666 (P).

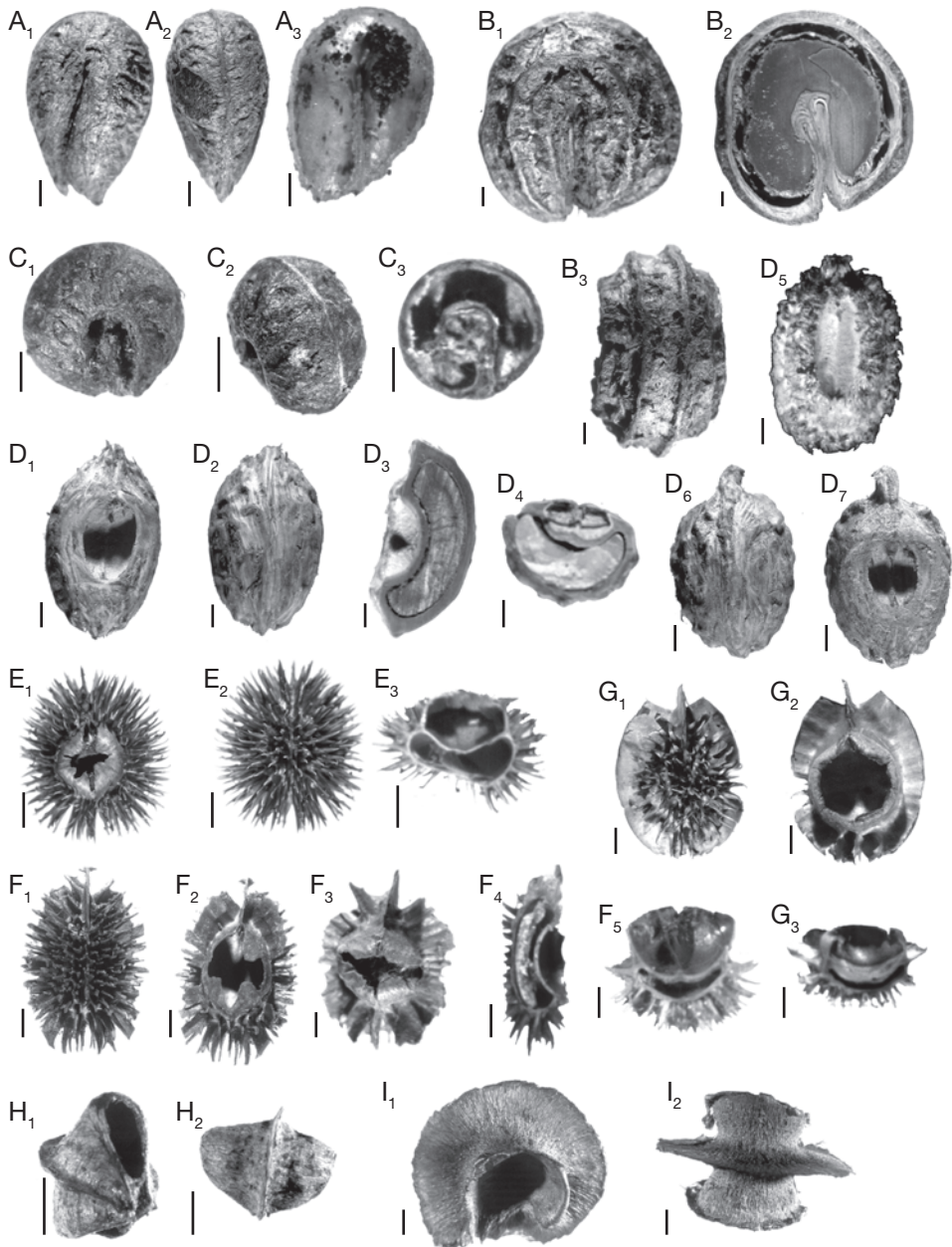


FIG. 7. — Endocarps of Menispermaceae: **A**, *Hyperbaena domingensis* (DC.) Benth., Stehlé 297; **A**₁, lateral view; **A**₂, dorsal view; **A**₃, sagittal section; **B**, *Hyperbaena laurifolia* (Poir.) Urb., Richard s.n.; **B**₁, lateral view; **B**₂, sagittal section; **B**₃, dorsal view; **C**, *Hypserpa nitida* Miers ex Benth., *H. Bon* 55665; **C**₁, lateral view; **C**₂, dorsal view; **C**₃, sagittal section; **D**, *Jateorhiza macrantha* (Hook.f.) Exell & Mendonça; **D**₁–**D**₄, *Bretelea* 623; **D**₁, ventral view; **D**₂, dorsal view; **D**₃, sagittal section; **D**₄, transverse section; **D**₅, ventral view, *Verdicourt* 1905A; **D**₆, **D**₇, *Klaine* 154; **D**₆, dorsal view; **D**₇, ventral view; **E**, *Kolobopetalum auriculatum* Engl., *R. Letouzey* 11196; **E**₁, ventral view; **E**₂, dorsal view; **E**₃, transverse section; **F**, *Kolobopetalum chevalieri* (Hutch. & Dalziel) Troupin; **F**₁, **F**₂, *C. Tisserant* 1020; **F**₁, dorsal view; **F**₂, ventral view; **F**₃, **F**₅, *J. G. Adam* 25723; **F**₃, ventral view; **F**₅, transverse section; **F**₄, sagittal section, *C. Tisserant* 1020; **G**, *Kolobopetalum ovatum* Stapf, *Jansen* 2063; **G**₁, dorsal view; **G**₂, ventral view; **G**₃, transverse section; **H**, *Legnephora microcarpa* Forman, *H. Streimann* & *A. Kairo* 21169; **H**₁, semi-ventral view; **H**₂, dorsal view; **I**, *Legnephora minutiflora* (K.Schum.) Diels, *M. S. Clemens* 8682; **I**₁, lateral view; **I**₂, dorsal view. Scale bars: 2 mm.

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with partly excavated faces; one slight dorsal ridge; surface reticulate; dorsal face convex; double external condyle not perforated, a strip partly hiding it ventrally. Length, 9.1 mm; width, 8.2 mm; thickness, 4.8 mm.

Pachygone ovata

(Poir.) Miers ex Hook.f. & T. Thomson
(Fig. 9C)

MATERIAL EXAMINED. — **India.** *W. Arnot s.n.* (P).

DESCRIPTION

Endocarp reniform, rounded in outline; one slight dorsal ridge; surface reticulate; one limb obtuse, the other pointed; central area partly filled. Length, 7.3 mm; width, 6.5 mm; thickness, 4.3 mm.

33. Genus *Parabaena* Miers

Parabaena denudata Diels
(Fig. 9E)

MATERIAL EXAMINED. — Unknown origin, collector unknown (Reid collection, BM).

DESCRIPTION

Endocarp straight, elliptic in outline with ventral condyle; strong dorsal longitudinal ridge; keeled apex, obtuse at base; surface covered with short spines; simple intrusive condyle developed in protruding ventral chamber, the chamber wall made by curved spines, moderate elliptic aperture 3.0 mm long and 0.9 mm wide. Length, 7.5 mm; width, 6.0 mm; thickness, 4.4 mm.

Parabaena echinocarpa Diels
(Fig. 9D)

MATERIAL EXAMINED. — **Philippines.** Mindanao, Gamaguin Island, *Elmer 14224* (P).

DESCRIPTION

Endocarp straight, elliptic in outline with ventral condyle; no ridges; obtuse at base and apex; surface densely covered with long spines; simple intrusive condyle developed in protruding ventral chamber, the chamber wall made by curved spines, moderate circular aperture 3.7 mm long and 3.0 mm wide. Length, 8.5 mm; width, 5.9 mm; thickness, 4.9 mm.

Parabaena megalocarpa Merr.
(Fig. 9F)

MATERIAL EXAMINED. — **Malaysia.** Sabah, Elphinstone, *Elmer 20675* (P).

DESCRIPTION

Endocarp straight, elliptic in outline with ventral condyle; no ridges; keeled at apex, obtuse at base; surface densely covered with long spines, spines connected by small walls along longitudinal lines; simple intrusive condyle developed in protruding ventral chamber, some spines partly fused with the chamber walls, closed aperture. Length, 21.9 mm; width, 13.4 mm; thickness, 11.4 mm.

Parabaena sagittata Miers
(Fig. 9G)

MATERIAL EXAMINED. — **Vietnam.** Bavi Mount, *B. Balansa 3899* (P).

DESCRIPTION

Endocarp straight, rounded in outline with a ventral condyle; two dorsal ridges, three to four lateral ridges, all ridges bearing strong and short spines; keeled at apex, obtuse at base; surface smooth between the spiny ridges; simple intrusive condyle without protruding chamber, large and circular aperture 2.5 mm long and 2.2 mm wide. Length, 6.1 mm; width, 5.1 mm; thickness, 3.6 mm.

34. Genus *Penianthus* Miers

Penianthus camerounensis Dekker
(Fig. 9H)

MATERIAL EXAMINED. — **Cameroon.** Yaoundé, Mkolngoas, *D. Dang 689* (P).

DESCRIPTION

Endocarp straight, elliptic in outline without condyle; no ridges, one ventral shallow ridge; surface smooth. Length, 25.2 mm; width, 13.4 mm; thickness, 12.0 mm.

Penianthus longifolius Miers
(Fig. 9I)

MATERIAL EXAMINED. — **Cameroon.** Akonolinga, Nkomo, *R. Letouzey 4224* (P).
Gabon. Bélinga, *N. Hallé & A. Le Thomas 455* (P).

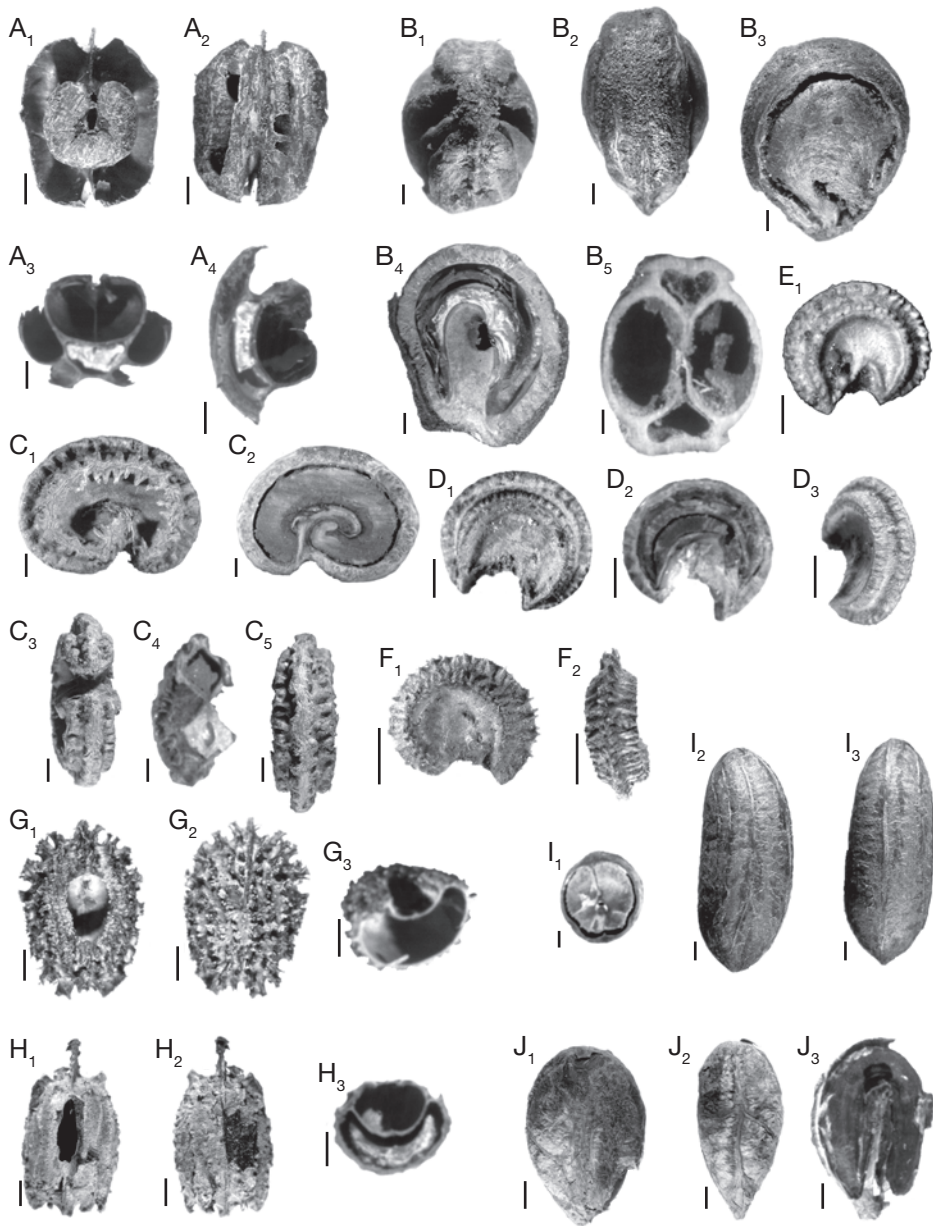


FIG. 8. — Endocarps of Menispermaceae: **A**, *Leptoterantha mayumbensis* (Exell) Troupin, *C. Tisserant 1099*; **A**₁, ventral view; **A**₂, dorsal view; **A**₃, transverse section; **A**₄, sagittal section; **B**, *Limacia scandens* Lour., *L. Pierre 1643*; **B**₁, ventral view; **B**₂, dorsal view; **B**₃, lateral view; **B**₄, sagittal section; **B**₅, transverse section; **C**, *Limaciopsis loagensis* Engl.; **C**₁–**C**₃, *C. Tisserant 1426*; **C**₁, lateral view; **C**₂, sagittal section; **C**₃, ventral view; **C**₄, transverse section, *R. Letouzey 12245*; **C**₅, dorsal view, *C. Tisserant 1426*; **D**, *Menispermum canadense* L., *Michaux s.n.*; **D**₁, lateral view; **D**₂, sagittal section; **D**₃, dorsal view; **E**, *Menispermum dauricum* DC., Reid collection; **E**₁, lateral view; **F**, *Menispermum diversifolium* (Miq.) Gagnep., *A. Henry 2509*; **F**₁, lateral view; **F**₂, dorsal view; **G**, *Odontocarya echinus* Barneby, *F. Woytkowski 5546*; **G**₁, ventral view; **G**₂, dorsal view; **G**₃, transverse section; **H**, *Odontocarya wullsclaegelii* (Eichler) Barneby, *Richard s.n.*; **H**₁, ventral view; **H**₂, dorsal view; **H**₃, transverse section; **I**, *Orthomene schomburgkii* (Miers) Barneby & Krukoff, *R. L. Froes 27519*; **I**₁, transverse section; **I**₂, lateral view; **I**₃, dorsal view; **J**, *Pachygone dasycarpa* Kurz, *E. Poilane 14876*; **J**₁, lateral view; **J**₂, dorsal view; **J**₃, sagittal section. Scale bars: 2 mm.

DESCRIPTION

Endocarp straight, elliptic in outline without condyle; sometimes a slight dorsal ridge, one ventral shallow groove; smooth surface. Length, 21.9-26.7 mm; width, 11.3-11.9 mm; thickness, 9.9-10.7 mm.

35. Genus *Pericampylus* Miers

Pericampylus glaucus (Lam.) Merr.
(Fig. 9J)

MATERIAL EXAMINED. — **Thailand**. Chian Mai, *F. Jacques* 67 (P).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with excavated faces; two dorsal ridges, two lateral ridges on each side, all ridges spiny; smooth surface; dorsal face with two lateral concavities; the two limbs ending at the same level, one slightly more inwards; double external condyle not perforated. Length, 5.7 mm; width, 5.5 mm; thickness, 2.4 mm.

36. Genus *Platytnospora* Diels

Platytnospora buchholzii (Engl.) Diels
(Fig. 9K)

MATERIAL EXAMINED. — **Cameroon**. Akwaya, Mbu, *R. Letouzey* 14139 (P).

DESCRIPTION

Endocarp straight, elliptic in outline with a ventral condyle; one dorsal ridge, no lateral ridges, one ventral ridge; keeled at base and strongly so at apex; ornamented surface with short, large and reticulated walls; simple intrusive condyle without protruding chamber, divided in two parts by the ventral ridge, broad circular aperture 3.5 mm in diameter. Length, 12.0 mm; width, 6.5 mm; thickness, 5.9 mm.

37. Genus *Pycnarrhena*

Miers ex Hook.f. & T. Thomson

Pycnarrhena longifolia (Decne. ex Miq.) Becc.
(Fig. 9L)

MATERIAL EXAMINED. — **Indonesia**. Sumatra, Aceh, *W. J. de Wilde* 12170 (L).

DESCRIPTION

Subglobose endocarp; no ridges; rugose surface; one

ventral shallow hollow. Length, 26.4 mm; width, 21.0 mm; thickness, 19.1 mm.

Pycnarrhena lucida (Teijsm. & Binn.) Miq.
(Fig. 9M)

MATERIAL EXAMINED. — **Thailand**. Chaiyaburi, Nawng Kai, *A. F. G. Kerr* 8516 (P).

DESCRIPTION

Endocarp subreniform, rounded in outline; no ridges; surface covered with fibres diverging from the small ventral face; no condyle. Length, 9.0 mm; width, 9.8 mm; thickness, 7.1 mm.

Pycnarrhena ozantha Diels
(Fig. 10A)

MATERIAL EXAMINED. — **Papua-New Guinea**. *D. Soyars* 24162 (L).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline without excavated faces; one dorsal ridge, two lateral ridges on each side; rugose surface; dorsal face convex; one limb ending more inwards; central area filled, condyle inconspicuous. Length, 12.9 mm; width, 10.5 mm; thickness, 10.5 mm.

38. Genus *Rhaptonea* Miers

Rhaptonea thouarsiana (Baill.) Diels
(Fig. 10B)

MATERIAL EXAMINED. — **Madagascar**. Antsiranana, Antalaha, *D. Ravelonarivo* 673 (P).

DESCRIPTION

Endocarp horseshoe-shaped, elliptic in outline without excavated faces; one dorsal ridge; surface rugose slightly ornamented; dorsal face convex; central area filled; condyle very limited. Length, 19.9 mm; width, 16.4 mm; thickness, 11.3 mm.

39. Genus *Rhigiocarya* Miers

Rhigiocarya racemifera Miers
(Fig. 10C)

MATERIAL EXAMINED. — **Gabon**. Libreville, *Klaine* 3242 (P).
Ivory Coast. Bouroukrou, *A. Chevalier* 16827 (P).

DESCRIPTION

Endocarp straight, elliptic in outline with ventral condyle; one dorsal ridge, one or no lateral wing on each side; surface densely covered with long and blunt spines; simple intrusive condyle developed in protruding ventral chamber, slight and longitudinal aperture 5.3-7.5 mm long and 0.5-0.9 mm wide. Length, 15.8-17.8 mm; width, 10.0-12.2 mm; thickness, 7.6-8.4 mm.

40. Genus *Sarcolophium* Troupin*Sarcolophium suberosum* (Diels) Troupin
(Fig. 10D)

MATERIAL EXAMINED. — **Gabon**. Libreville, *Klaine 2134* (P).

DESCRIPTION

Endocarp straight, rounded in outline with ventral condyle; one dorsal ridge continued on ventral face; surface covered with short points; simple intrusive condyle developed in large protruding ventral chamber, large elliptic aperture 4.0 mm long and 2.1 mm wide. Length, 9.9 mm; width, 7.1 mm; thickness, 5.3 mm.

41. Genus *Sarcopetalum* F.Muell.*Sarcopetalum harveyanum* F.Muell.
(Fig. 10E)

MATERIAL EXAMINED. — **Australia**. Queensland, Tinaroo, *M. van Balgooy 1561* (L).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with excavated faces; two dorsal ridges, two lateral ridges on each side, all ridges bearing about 16 strong and short spines; dorsal faces with two lateral concavities; smooth surface; limbs of same length, ending distant from one another; double external condyle not perforated, large central area. Length, 5.9 mm; width, 4.6 mm; thickness, 2.9 mm.

42. Genus *Sciadotenia* Miers*Sciadotenia cayennensis* Benth.
(Fig. 10F)

MATERIAL EXAMINED. — **French Guiana**. Saül, *Oldeman 1977* (P).

DESCRIPTION

Endocarp reniform; surface irregular with shallow alveoli; central area totally perforated. Length, 8.1 mm; width, 6.3 mm; thickness, 5.8 mm.

Sciadotenia eichleriana Moldenke
(Fig. 10G)

MATERIAL EXAMINED. — **Brazil**. *G. T. Prance et al. 25705* (U).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with excavated faces; surface irregular and reticulate; dorsal face convex; one limb more curved; double lateral condyle not perforated. Length, 12.7 mm; width, 10.5 mm; thickness, 7.1 mm.

43. Genus *Sinomenium* Diels*Sinomenium acutum*
(Thunb.) Rehder & E.H. Wilson
(Fig. 10I)

MATERIAL EXAMINED. — **Kew Hort.** Collector unknown (Reid collection, BM).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with excavated faces; one dorsal ridge, one lateral ridge on each side, connected by more than 30 transverse ridges; smooth surface; dorsal face with two lateral concavities; double external condyle, not perforated, making a large central area with a conspicuous hollow near one limb, with a comma-shaped ridge bordering it. Length, 4.9-5.7 mm; width, 3.0-3.7 mm; thickness, 1.4-1.5 mm.

44. Genus *Sphenocentrum* Pierre*Sphenocentrum jollyanum* Pierre
(Fig. 10H)

MATERIAL EXAMINED. — **Ivory Coast**. Guidéko, *A. Chevalier 16385* (P).

DESCRIPTION

Endocarp straight, elliptic in outline without condyle; no ridges, one large ventral groove ending into a hole at one end; holed end less sharp than the other; surface rugose. Length, 18.8 mm; width, 8.4 mm; thickness, 8.1 mm.

45. Genus *Spirospermum* Thou.

Spirospermum penduliflorum DC.
(Fig. 10J)

MATERIAL EXAMINED. — **Madagascar**. Sainte Marie, *Boivin 1834* (P).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with flat faces; one dorsal ridge, one lateral groove on each side, numerous transverse ridges; dorsal face with two lateral concavities; central area filled, limiting the double external condyle to a line between central and horseshoe-shaped areas. Length, 10.7 mm; width, 10.5 mm; thickness, 5.1 mm.

46. Genus *Stephania* Lour.

Stephania abyssinica (Dill. & Rich.) Walp.
(Fig. 10K)

MATERIAL EXAMINED. — **Ethiopia**. *Quartin-Dillon & Petit s.n.* (P). — Collector unknown (Reid collection, BM).

DESCRIPTION

Endocarp horseshoe-shaped, elliptic in outline with excavated faces; one dorsal ridge, one lateral ridge on each side, connected by about nine strip-like transverse ridges; dorsal face with two lateral concavities; smooth surface; one limb slightly to strongly longer than the other; double external condyle, not perforated. Length, 7.1 mm; width, 5.3-5.4 mm; thickness, 2.1-2.4 mm.

Stephania dinklagei (Engl.) Diels
(Fig. 10L)

MATERIAL EXAMINED. — **Central African Republic**. Oubangui, Boukoko, *C. Tisserant 1862* (P). — Collector unknown (Reid collection, BM).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with excavated faces; two dorsal ridges, one lateral ridge on each side, all ridges bearing about 30 hook-ended spines; dorsal face with two lateral concavities; smooth surface; the two limbs ending at the same level and approximately parallel; double external condyle, perforated or not. Length, 7.0 mm; width, 6.4-6.8 mm; thickness, 2.4-3.0 mm.

Stephania erecta Craib
(Fig. 11A)

MATERIAL EXAMINED. — **Laos**. *Harmand s.n.* (P).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with excavated faces; two dorsal ridges, one lateral ridge on each side, connected by about 18 strong transverse ridge; dorsal face with two lateral concavities; smooth surface; one limb shorter and ending more inwards than the other; double external condyle, not perforated. Length, 9.2 mm; width, 8.6 mm; thickness, 4.6 mm.

Stephania glabra (Roxb.) Miers
(Fig. 11C)

MATERIAL EXAMINED. — **Thailand**. *H. B. G. Garrett 1319* (P).

DESCRIPTION

Endocarp horseshoe-shaped, elliptic in outline with excavated faces; one dorsal ridge, one lateral ridge on each side, connected by about 26 transverse ridges; dorsal face with two lateral concavities; smooth surface; the two limbs ending at the same level and parallel; double external condyle, perforated. Length, 6.5 mm; width, 5.0 mm; thickness, 1.7 mm.

Stephania japonica (Thunb.) Miers
(Fig. 11B)

MATERIAL EXAMINED. — **Vietnam**. Nam Ky, Bien Hoa, *A. Chevalier 29826* (P).

Japan. Luiki, Oshima, *U. Faurie 3835* (P).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with excavated faces; two dorsal ridges and one lateral on each side, each ridge bearing about 13 diversely developed transverse strips; dorsal face with two lateral concavities; smooth surface; the two limbs ending at the same level and parallel; double external condyle, perforated or not. Length, 5.8-6.5 mm; width, 5.7-6.0 mm; thickness, 2.4-2.8 mm.

Stephania laetificata (Miers) Benth.
(Fig. 11D)

MATERIAL EXAMINED. — **Cameroon**. Bertoua, *R. Letouzey 2989* (P).

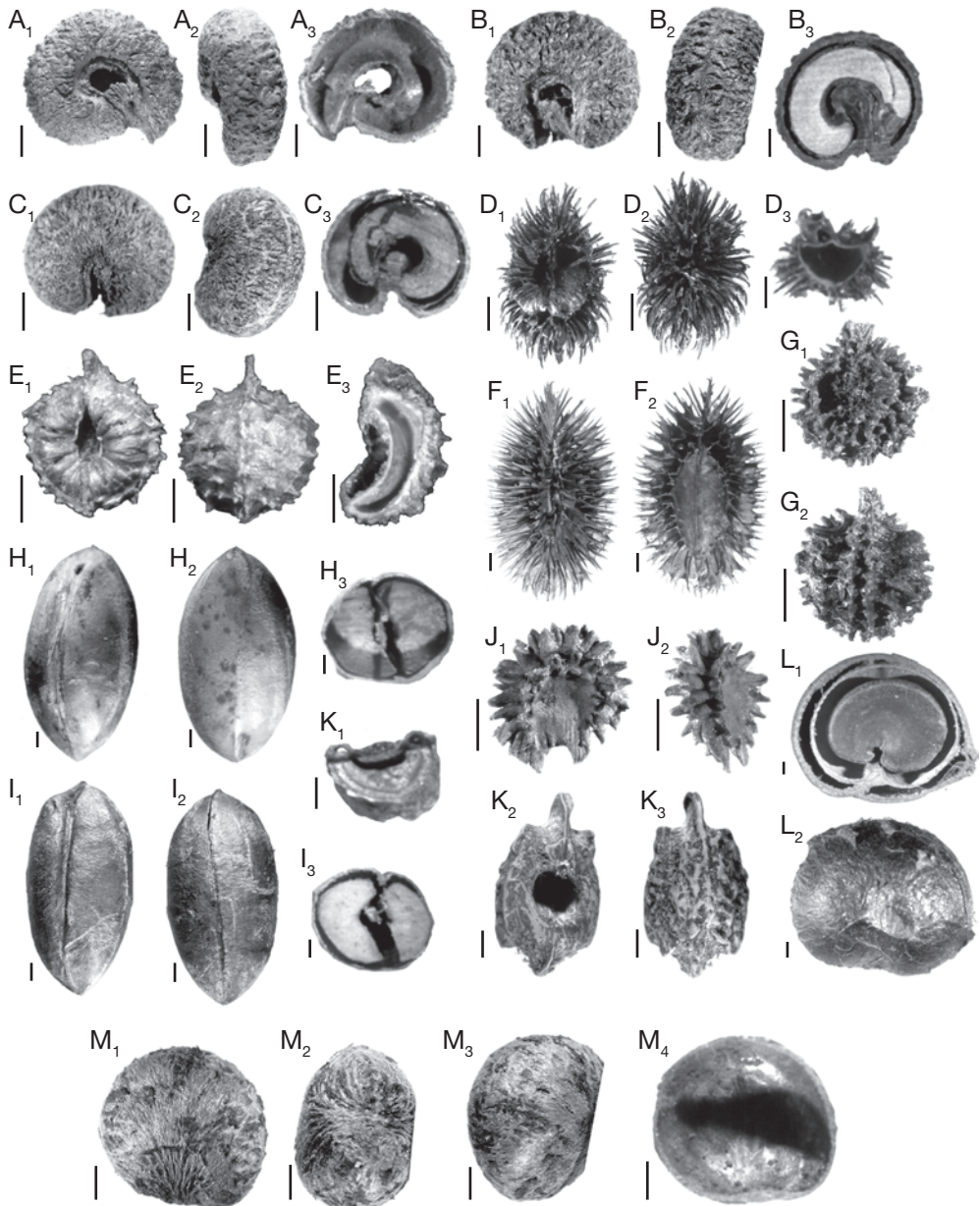


FIG. 9. — Endocarps of Menispermaceae: **A**, *Pachygone nitida* Pierre ex Gagnep., *Thorel 2104*; **A**₁, lateral view; **A**₂, dorsal view; **A**₃, sagittal section; **B**, *Pachygone odorifera* Miers, *E. Poilane 4666*; **B**₁, lateral view; **B**₂, dorsal view; **B**₃, sagittal section; **C**, *Pachygone ovata* (Poir.) Miers ex Hook.f. & T.Thomson, *Arnott s.n.*; **C**₁, lateral view; **C**₂, dorsal view; **C**₃, sagittal section; **D**, *Parabaena echinocarpa* Diels, *Elmer 14224*; **D**₁, ventral view; **D**₂, dorsal view; **D**₃, transverse section; **E**, *Parabaena denudata* Diels, Reid collection; **E**₁, ventral view; **E**₂, dorsal view; **E**₃, sagittal section; **F**, *Parabaena megalocarpa* Merr., *Elmer 20675*; **F**₁, dorsal view; **F**₂, ventral view; **G**, *Parabaena sagittata* Miers, *B. Balansa 3899*; **G**₁, ventral view; **G**₂, dorsal view; **H**, *Penianthus camerounensis* Dekker, *D. Dang 689*; **H**₁, ventral view; **H**₂, dorsal view; **H**₃, transverse section; **I**, *Penianthus longifolius* Miers, *R. Letouzey 4224*; **I**₁, ventral view; **I**₂, dorsal view; **I**₃, transverse section; **J**, *Pericampylus glaucus* (Lam.) Merr., *F. Jacques 67*; **J**₁, lateral view; **J**₂, dorsal view; **K**, *Platytnospora bulchholzii* (Engl.) Diels, *R. Letouzey 14139*; **K**₁, transverse section; **K**₂, ventral view; **K**₃, dorsal view; **L**, *Pycnarrhena longifolia* (Decne. ex Miq.) Becc., *W. J. de Wilde 12170*; **L**₁, sagittal section; **L**₂, lateral view; **M**, *Pycnarrhena lucida* (Teijsm. & Binn.) Miq., *A. F. G. Kerr 8516*; **M**₁, lateral view; **M**₂, ventral view; **M**₃, dorsal view; **M**₄, sagittal section. Scale bars: 2 mm.

DESCRIPTION

Endocarp horseshoe-shaped, elliptic in outline with excavated faces; two dorsal ridges bearing about 12 longitudinal strips, one lateral ridge with small hollows on each side; dorsal face with two lateral concavities; smooth surface; one limb ending inwards and the other outwards, giving the impression of being tilted; double external condyle, not perforated. Length, 10.4 mm; width, 8.4 mm; thickness, 5.6 mm.

Stephania longa Lour.
(Fig. 11E)

MATERIAL EXAMINED. — Vietnam. Tho Mat, *H. Bon 2192bis* (P).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with excavated faces; two dorsal ridges bearing about 12 spines, one lateral ridge on each side bearing about 12 transverse strips; dorsal face with two lateral concavities; smooth surface; the two limbs ending at the same level and parallel; double external condyle, perforated. Length, 6.1 mm; width, 5.0 mm; thickness, 1.9 mm.

Stephania pierrei Diels
(Fig. 11F)

MATERIAL EXAMINED. — Vietnam. Cana, *E. Poilane 17870* (P).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with excavated faces; two dorsal ridges, one lateral ridge on each side, connected by about 12 transverse ridges; dorsal face with two lateral concavities; smooth surface; the two limbs ending approximately parallel and at the same level; double external condyle, perforated. Length, 7.0 mm; width, 6.8 mm; thickness, 2.8 mm.

Stephania rotunda Lour.
(Fig. 11G)

MATERIAL EXAMINED. — India. *A. C. Chatterjee s.n.* (P).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with excavated faces; two dorsal ridges, one lateral

ridge on each side, all ridges bearing about 13 small and slightly hook-ended spines; dorsal face with two lateral concavities; smooth surface; the two limbs ending at the same level and parallel; double external condyle, perforated. Length, 5.9 mm; width, 5.2 mm; thickness, 2.6 mm.

Stephania sinica Diels
(Fig. 11H)

MATERIAL EXAMINED. — China. Sichuan, *Farges 41* (P).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline with excavated faces; two dorsal ridges, one lateral ridge on each side, all ridges bearing about 13 small outgrowths; dorsal face with two lateral concavities; smooth surface; the two limbs ending at the same level, one more inwards; double external condyle, not perforated. Length, 6.4 mm; width, 6.2 mm; thickness, 3.3 mm.

47. Genus *Strychnopsis* Baill.

Strychnopsis thouarsii Baill.
(Fig. 11I)

MATERIAL EXAMINED. — Madagascar. *C. Birkinshaw 575* (P).

DESCRIPTION

Endocarp horseshoe-shaped, rounded in outline without excavated faces; one dorsal ridge, one slight lateral ridge on each side; surface slightly reticulated; dorsal face convex; central area filled, limiting the condyle to a sharp line surrounding it. Length, 10.5 mm; width, 10.2 mm; thickness, 5.6 mm.

48. Genus *Synclisia* Benth.

Synclisia scabrida Miers
(Fig. 11J)

MATERIAL EXAMINED. — Central African Republic. Oubangui, Boukoko, *C. Tisserant 1995* (P).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; one dorsal ridge; surface rugose with some grooves; limbs

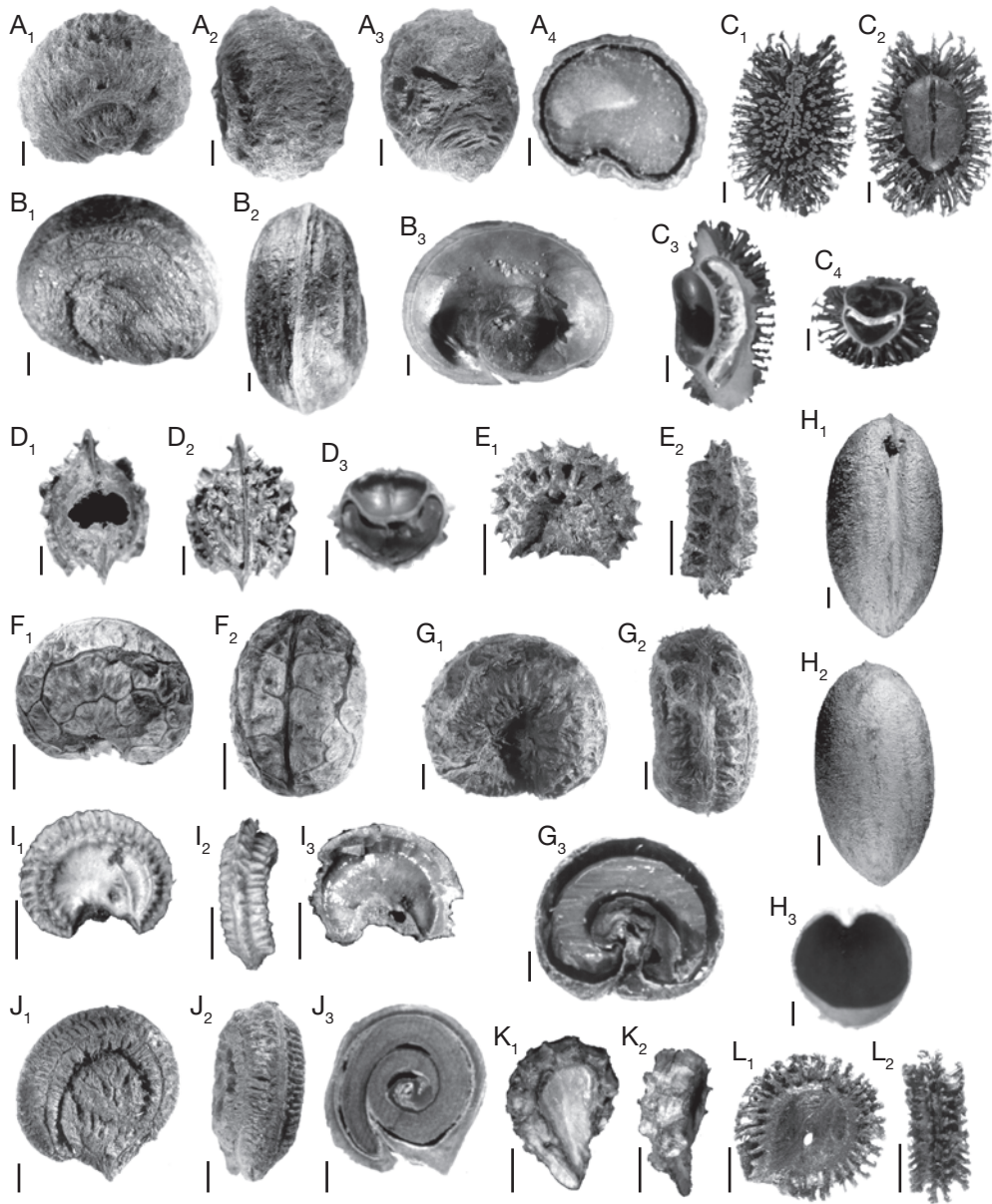


FIG. 10. — Endocarps of Menispermaceae: **A**, *Pycnarrhena ozantha* Diels, *D. Soyers* 24162; **A**₁, lateral view; **A**₂, dorsal view; **A**₃, ventral view; **A**₄, sagittal section; **B**, *Rhaptonema thouarsiana* (Baill.) Diels, *D. Ravelonarivo* 673; **B**₁, lateral view; **B**₂, dorsal view; **B**₃, sagittal section; **C**, *Rhigiocarya racemifera* Miens; **C**₁, **C**₂, **C**₄, *Klaine* 2342; **C**₁, dorsal view; **C**₂, ventral view; **C**₄, transverse section; **C**₃, sagittal section; **D**, *Sarcophium suberosum* (Diels) Troupin, *Klaine* 2134; **D**₁, ventral view; **D**₂, dorsal view; **D**₃, transverse section; **E**, *Sarcopetalum harveyanum* F.Muell., *M. van Balgooy* 1561; **E**₁, lateral view; **E**₂, dorsal view; **F**, *Sciadotenia cayennensis* Benth., *Oldeman* 1977; **F**₁, lateral view; **F**₂, dorsal view; **G**, *Sciadotenia eichleriana* Moldenke, *G. T. Prance et al.* 25705; **G**₁, lateral view; **G**₂, dorsal view; **G**₃, sagittal section; **H**, *Sphenocentrum jollyanum* Pierre, *A. Chevalier* 16385; **H**₁, ventral view; **H**₂, dorsal view; **H**₃, transverse section; **I**, *Sinomenium acutum* (Thunb.) Rehder & E.H.Wilson, *Kew Hort*; **I**₁, lateral view; **I**₂, dorsal view; **I**₃, sagittal section; **J**, *Spirospermum penduliflorum* DC., *Boivin* 1834; **J**₁, lateral view; **J**₂, dorsal view; **J**₃, sagittal section; **K**, *Stephania abyssinica* (Dill. & Rich.) Walp., *Quartin-Dillon & Petit s.n.*; **K**₁, lateral view; **K**₂, dorsal view; **L**, *Stephania dinklagei* (Engl.) Diels, *C. Tisserant* 1862; **L**₁, lateral view; **L**₂, dorsal view. Scale bars: 2 mm.

ending parallel and of same length; double intrusive lateral condyle very thin. Length, 13.7 mm; width, 9.3 mm; thickness, 6.4 mm.

49. Genus *Syntriandrium* Engl.

Syntriandrium preussii Engl.

(Fig. 11L)

MATERIAL EXAMINED. — **Gabon**. Libreville, *Klaine* 1868 (P).

Central African Republic. Oubangui, Boukoko, *C. Tisserant* 1256 (P).

DESCRIPTION

Endocarp straight, rounded in outline with ventral condyle; one dorsal ridge, three slightly developed lateral ridges on each side, the outer one pointed at its extremities; keeled at apex and slightly so at base; surface rugose; simple intrusive condyle developed in large protruding ventral chamber, transverse elliptic aperture 5.0 mm long and 1.0-1.5 mm wide. Length, 9.5-12.5 mm; width, 6.9-8.6 mm; thickness, 6.1-6.5 mm.

50. Genus *Syrrhonema* Miers

Syrrhonema fasciculatum Miers

(Fig. 11K)

MATERIAL EXAMINED. — **Gabon**. Libreville, *Klaine* 2580 (P).

DESCRIPTION

Annular endocarp, rounded in outline; one dorsal ring; dorsal face with two lateral concavities; surface reticulate; limbs joined; central area totally perforated. Length, 13.0 mm; width, 12.0 mm; thickness, 8.7 mm.

51. Genus *Telitoxicum* Moldenke

Telitoxicum sp.

(not illustrated)

MATERIAL EXAMINED. — **Guyana**. *R. C. Ek* 1034 (U).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; one dorsal groove, one lateral groove on each side; surface with shallow reticulated grooves; one limb thinner and slightly shorter than the other; condyle

not visible externally. Length, 25.2 mm; width, 17.9 mm; thickness, 14.1 mm.

52. Genus *Tiliacora* Colebr.

Tiliacora acuminata Miers

(Fig. 12A)

MATERIAL EXAMINED. — **Vietnam**. Cult. Hort. Bot., Ho Chi Minh City, *Hiệp* 819 (P).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; one dorsal ridge, no lateral ridges; surface reticulated; limbs ending comma-shaped; double intrusive lateral condyle. Length, 9.0 mm; width, 5.8 mm; thickness, 4.9 mm.

Tiliacora dielsiana Hutch. & Dalziel

(Fig. 12B)

MATERIAL EXAMINED. — **Ghana**. Gold Coast, Collector unknown (Reid collection, BM).

DESCRIPTION

Endocarp hairpin-shaped, globular in outline; one dorsal band, no lateral ridges; numerous reticulated bridges connecting the dorsal band and the lateral face, delimiting an elongated chamber; double intrusive lateral condyle filled by sclerified tissue. Length, 16.4 mm; width, 15.8 mm; thickness, 16.6 mm.

Tiliacora funifera (Miers) Oliv.

(Fig. 12C)

MATERIAL EXAMINED. — Unknown origin, *J. R. Dale* 3130 (Reid collection, BM).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; one dorsal ridge bordered by two lateral concavities; some transversal ridges, sometimes inconspicuous or not connected between dorsal ridge and lateral surface; rugose surface; the two limbs of same size; double intrusive lateral condyle. Length, 10.8 mm; width, 7.9 mm; thickness, 6.0 mm.

Tiliacora klaineana (Pierre) Diels

(Fig. 12D)

MATERIAL EXAMINED. — **Gabon**. Libreville, *Klaine* 3208 (P).

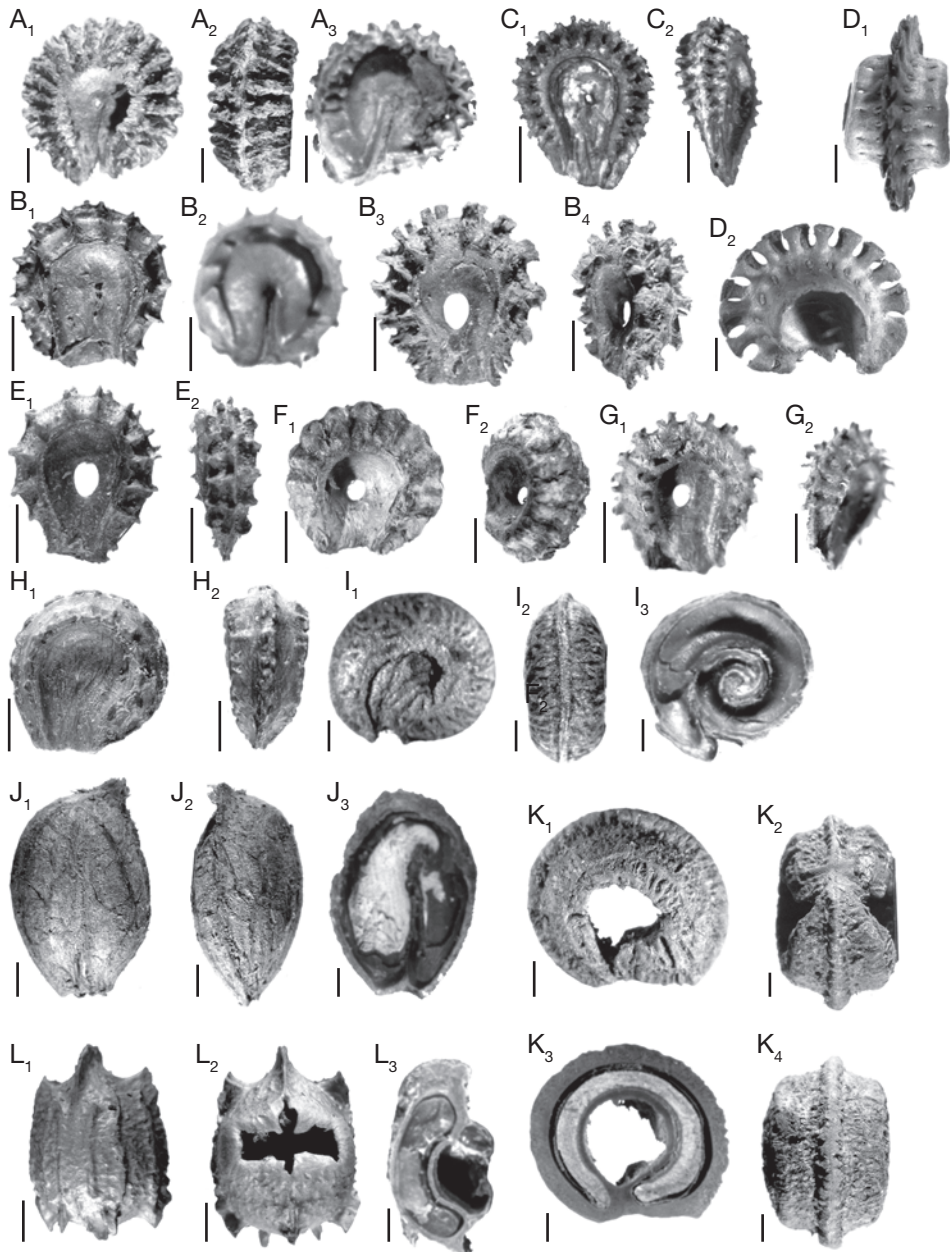


FIG. 11. — Endocarps of Menispermaceae: **A**, *Stephania erecta* Craib, *Harmand s.n.*; **A**₁, lateral view; **A**₂, dorsal view; **A**₃, sagittal section; **B**, *Stephania japonica* (Thunb.) Miers; **B**₁, **B**₂, *U. Faurie 3835*; **B**₁, lateral view; **B**₂, sagittal section; **B**₃, **B**₄, *A. Chevalier 29826*; **B**₃, lateral view; **B**₄, dorsal view; **C**, *Stephania glabra* (Roxb.) Miers, *H. B. G. Garrett 1319*; **C**₁, lateral view; **C**₂, dorsal view; **D**, *Stephania laetificata* (Miers) Benth., *R. Letouzey 2989*; **D**₁, dorsal view; **D**₂, lateral view; **E**, *Stephania longa* Lour., *H. Bon 2192bis*; **E**₁, lateral view; **E**₂, dorsal view; **F**, *Stephania pierrei* Diels, *E. Poilane 17870*; **F**₁, lateral view; **F**₂, semi-dorsal view; **G**, *Stephania rotunda* Lour., *A. C. Chatterjee s.n.*; **G**₁, lateral view; **G**₂, dorsal view; **H**, *Stephania sinica* Diels, *Farges 41*; **H**₁, lateral view; **H**₂, dorsal view; **I**, *Strychnopsis thoursii* Baill., *C. Birkinshaw 575*; **I**₁, lateral view; **I**₂, dorsal view; **I**₃, sagittal section; **J**, *Synclisia scabrada* Miers, *C. Tisserant 1995*; **J**₁, lateral view; **J**₂, dorsal view; **J**₃, sagittal section; **K**, *Syrhonenema fasciculatum* Miers, *Klaine 2580*; **K**₁, lateral view; **K**₂, ventral view; **K**₃, sagittal section; **K**₄, dorsal view; **L**, *Syntriandrium preussii* Engl.; **L**₁, **L**₂, *C. Tisserant 1256*; **L**₁, dorsal view; **L**₂, ventral view; **L**₃, sagittal section, *Klaine 1868*. Scale bars: 2 mm.

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; one dorsal ridge, no lateral ridges; surface slightly ornamented; limbs ending comma-shaped; double intrusive lateral condyle. Length, 15.8 mm; width, 8.4 mm; thickness, 6.4 mm.

Tiliacora louisii Troupin

(Fig. 12E)

MATERIAL EXAMINED. — Unknown origin, *R. Germain 181* (Reid collection, BM).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; one dorsal line, no ridges; irregular surface without conspicuous ornamentation; one limb slightly bigger than the other; condyle not visible externally. Length, 9.2 mm; width, 5.9 mm; thickness, 5.5 mm.

Tiliacora macrophylla (Pierre) Diels

(Fig. 12F)

MATERIAL EXAMINED. — **Gabon**. Libreville, *Klaine 1275* (P).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; one dorsal ridge, no lateral ridges, about 15 dorsal outgrowths on each side; rugose surface; limbs ending comma-shaped; double intrusive lateral condyle. Length, 13.7 mm; width, 9.0 mm; thickness, 6.5 mm.

Tiliacora ovalis (Pierre) Diels

(Fig. 12G)

MATERIAL EXAMINED. — **Gabon**. Libreville, *Klaine 1679* (P).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; one dorsal ridge; surface almost smooth; limbs ending comma-shaped; double intrusive lateral condyle. Length, 14.9 mm; width, 9.8 mm; thickness, 7.1 mm.

Tiliacora triandra (Roxb.) Diels

(Fig. 12H)

MATERIAL EXAMINED. — **Vietnam**. Nhatrang, *E. Poilane 2936* (P). — Collector unknown (Reid collection, BM).

DESCRIPTION

Endocarp hairpin-shaped, rounded in outline; one dorsal ridge, numerous reticulated transverse ridges; rugose surface; limbs very short, one slightly longer than the other; double intrusive lateral condyle. Length, 7.8-8.1 mm; width, 6.2-7.2 mm; thickness, 2.6-5.4 mm.

53. Genus *Tinomiscium*

Miers ex Hook.f. & T.Thomson

Tinomiscium petiolare Miers

(Fig. 12I)

MATERIAL EXAMINED. — **Indonesia**. Cult. Hort. Bog., *F Jacques 13* (P). — Peutjang Island, *N. Wirawan 433* (P). **Vietnam**. *E. Poilane 13574* (P).

DESCRIPTION

Endocarp straight, elliptic in outline without condyle; one slight dorsal ridge; rugose surface ornamented numerous small hollows sometimes reticulated; ventral face concave, bearing an outgrowth at one end. Global shape variable. Length, 20.0-22.1 mm; width, 12.0-13.1 mm; thickness, 6.2-6.6 mm.

54. Genus *Tinospora* Miers

Tinospora arfakiana Becc.

(Fig. 12J)

MATERIAL EXAMINED. — **Papua-New Guinea**. *A. Kostermans 2898* (L).

DESCRIPTION

Endocarp straight, elliptic in outline with a ventral condyle; one dorsal ridge only at apex, no lateral ridges; obtuse at base and apex; smooth surface; simple intrusive condyle without protruding chamber, moderate elliptical aperture 9.8 mm long and 3.3 mm wide, a longitudinal and high ventral strip separating the condyle in two parts. Length, 24.9 mm; width, 19.5 mm; thickness, 16.5 mm.

Tinospora caffra (Miers) Troupin

(not illustrated)

MATERIAL EXAMINED. — **Tanzania**. Tanganyika, Ukesu Island, collector unknown n° 5066 (Reid collection, BM).

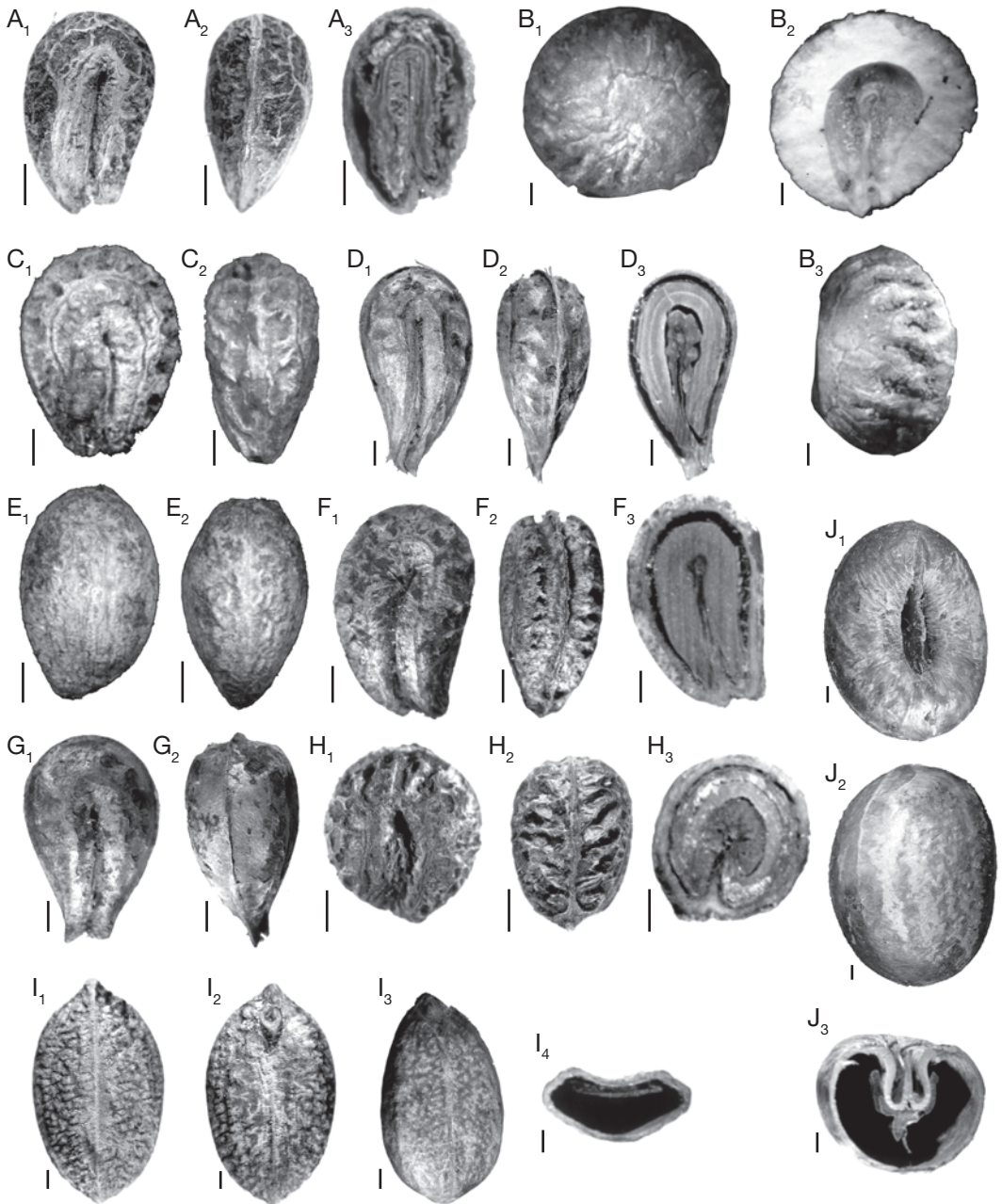


FIG. 12. — Endocarps of Menispermaceae: **A**, *Tiliacora acuminata* Miers, *Hiêp 819*; **A**₁, lateral view; **A**₂, dorsal view; **A**₃, sagittal section; **B**, *Tiliacora dielsiana* Hutch. & Dalziel, Reid collection; **B**₁, lateral view; **B**₂, sagittal section; **B**₃, semi-dorsal view; **C**, *Tiliacora funifera* (Miers) Oliv., *J. R. Dale 3130*; **C**₁, lateral view; **C**₂, dorsal view; **D**, *Tiliacora klaineana* (Pierre) Diels, *Klaine 3208*; **D**₁, lateral view; **D**₂, dorsal view; **D**₃, sagittal section; **E**, *Tiliacora louisii* Troupin, *R. Germain 181*; **E**₁, lateral view; **E**₂, dorsal view; **F**, *Tiliacora macrophylla* (Pierre) Diels, *Klaine 1275*; **F**₁, lateral view; **F**₂, dorsal view; **F**₃, sagittal section; **G**, *Tiliacora ovalis* (Pierre) Diels, *Klaine 1679*; **G**₁, lateral view; **G**₂, dorsal view; **H**, *Tiliacora triandra* (Roxb.) Diels, *E. Poilane 2936*; **H**₁, lateral view; **H**₂, dorsal view; **H**₃, sagittal section; **I**, *Tinomiscium petiolare* Miers; **I**₁, **I**₂, **I**₄, *E. Poilane 13574*; **I**₁, dorsal view; **I**₂, ventral view; **I**₄, transverse section; **I**₃, ventral view, *F. Jacques 13*; **J**, *Tinospora arfakiana* Becc., *A. Kostermans 2898*; **J**₁, ventral view; **J**₂, dorsal view; **J**₃, transverse section. Scale bars: 2 mm.

DESCRIPTION

Endocarp straight, elliptic in outline with a ventral condyle; one dorsal ridge, one ventral ridge also present in the condyle, one lateral ridge on each side; keeled at base and apex; slightly rugose surface; simple intrusive condyle without protruding chamber with aperture 3.1 mm long and 3.5 mm wide, aperture covered by endocarp expansions. Length, 8.7 mm; width, 5.9 mm; thickness, 4.4 mm.

Tinospora cordifolia
(Willd.) Hook.f. & T.Thomson
(Fig. 13A)

MATERIAL EXAMINED. — **India.** Trichinapally, *L. Pierre 3812* (P).

DESCRIPTION

Endocarp straight, elliptic in outline with a ventral condyle; one dorsal ridge continued on ventral face, no lateral ridges; keeled at base and apex; surface very irregular; simple intrusive condyle without protruding chamber, small circular aperture 1.0 mm long and 0.7 mm wide. Length, 8.2 mm; width, 5.9 mm; thickness, 5.2 mm.

Tinospora crispa (L.) Hook.f. & T.Thomson
(Fig. 13B)

MATERIAL EXAMINED. — **Thailand.** Chiang Rai, *J. F. Maxwell 89-469* (L).

DESCRIPTION

Endocarp straight, elliptic in outline with a ventral condyle; one dorsal ridge, no lateral ridges; keeled at apex and slightly so at base; smooth surface; simple intrusive condyle without protruding chamber, small elliptic aperture 1.5 mm long and 0.6 mm wide. Length, 8.6 mm; width, 6.5 mm; thickness, 5.8 mm.

Tinospora merrilliana Diels
(Fig. 13C)

MATERIAL EXAMINED. — **Philippines.** *Madulid et al. 995* (L).

DESCRIPTION

Endocarp straight, rounded in outline with a ventral condyle; one slight dorsal ridge, no lateral ridges; obtuse at base and apex; smooth surface; simple

intrusive condyle without protruding chamber, small elliptic aperture 1.6 mm long and 0.5 mm wide. Length, 6.5 mm; width, 6.4 mm; thickness, 5.1 mm.

Tinospora oblongifolia (Engl.) Troupin
(Fig. 13D)

MATERIAL EXAMINED. — **Kenya.** Kwale, *Gillet & Kibuwa 19891* (P).

Zanzibar. *Sacleux 836* (P).

DESCRIPTION

Endocarp straight, elliptic in outline with a ventral condyle; one dorsal ridge, three to four slightly developed lateral ridges on each side; broadly keeled at base and apex; smooth surface; simple intrusive condyle without protruding chamber, variation in the size of aperture 1.2-4.3 mm long and 0.6-2.4 mm wide. Length, 7.3-10.0 mm; width, 4.8-6.1 mm; thickness, 3.7-5.5 mm.

Tinospora reticulata Miers
(Fig. 13E)

MATERIAL EXAMINED. — **Philippines.** *M. Ramos & G. Edaña 44112* (P).

DESCRIPTION

Endocarp straight, rounded in outline with ventral condyle; one slightly conspicuous dorsal ridge; keeled at base and apex; surface rugose with some outgrowths; simple intrusive condyle without protruding chamber, small circular aperture 1.6 mm long and 1.0 mm wide. Length, 7.0 mm; width, 5.5 mm; thickness, 4.2 mm.

Tinospora sagittata (Oliv.) Gagnep.
(Fig. 13F)

MATERIAL EXAMINED. — **China.** Guizhou, *Cavalier 1914* (P).

DESCRIPTION

Endocarp straight, rounded in outline with a ventral condyle; smooth surface without any ridges; slightly keeled at apex, obtuse at base; simple intrusive condyle without protruding chamber, moderate circular aperture 2.0 mm long and 1.6 mm wide. Length, 6.5 mm; width, 7.0 mm; thickness, 4.4 mm.

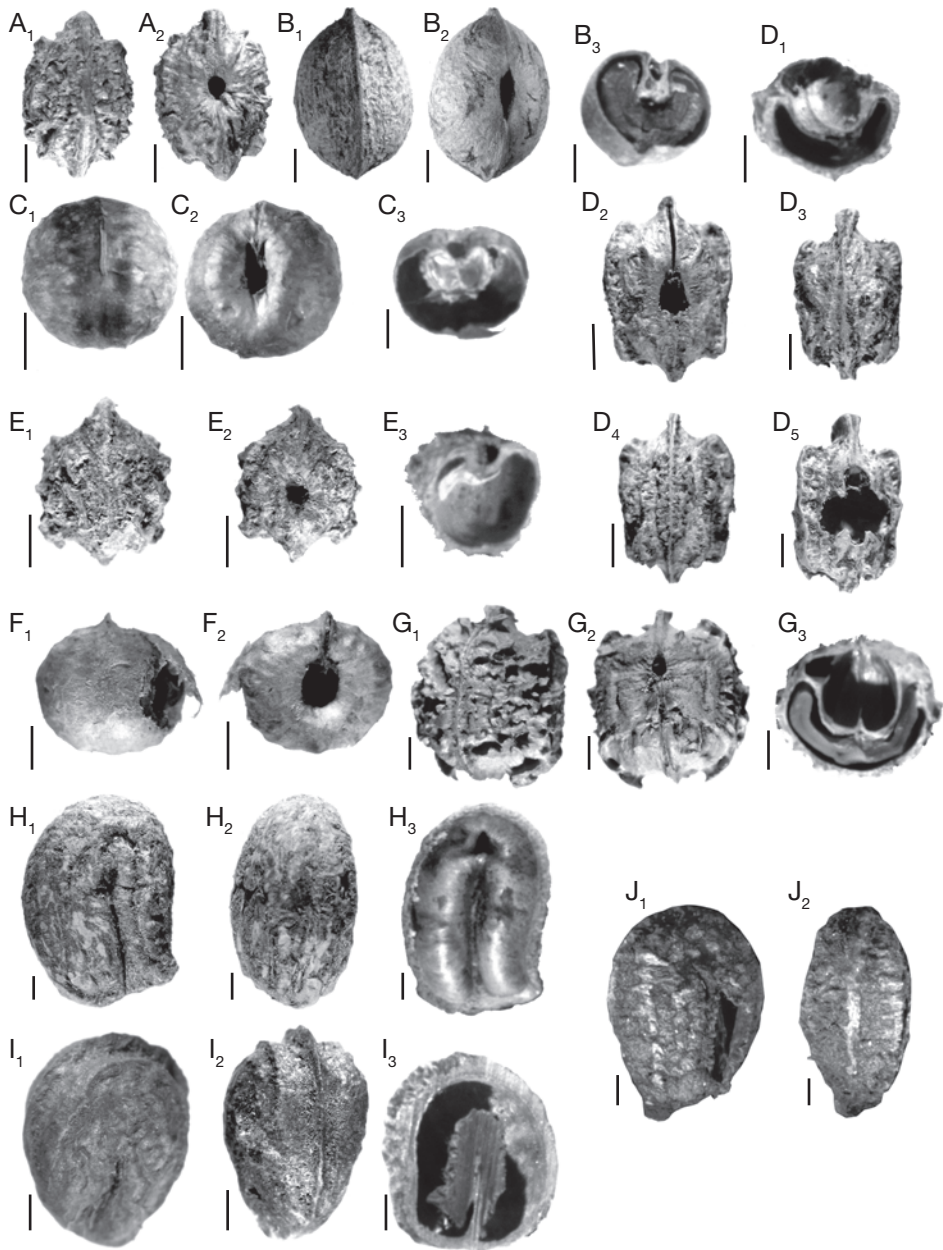


FIG. 13. — Endocarps of Menispermaceae: **A**, *Tinospora cordifolia* (Willd.) Hook.f. & T.Thomson, *L. Pierre* 3812; **A**₁, dorsal view; **A**₂, ventral view; **B**, *Tinospora crispa* (L.) Hook.f. & T.Thomson, *J. F. Maxwell* 89-469; **B**₁, dorsal view; **B**₂, ventral view; **B**₃, transverse section; **C**, *Tinospora merrilliana* Diels, *Madulid et al.* 995; **C**₁, dorsal view; **C**₂, ventral view; **C**₃, transverse section; **D**, *Tinospora oblongifolia* (Engl.) Troupin; **D**₁, **D**₃, **D**₅, *Sacleux* 836; **D**₁, transverse section; **D**₃, dorsal view; **D**₅, ventral view; **D**₂, **D**₄, *Gillet* 19891; **D**₂, ventral view; **D**₄, dorsal view; **E**, *Tinospora reticulata* Miers, *M. Ramos & G. Edaño* 44112; **E**₁, dorsal view; **E**₂, ventral view; **E**₃, transverse section; **F**, *Tinospora sagittata* (Oliv.) Gagnep., *Cavalier* 1914; **F**₁, dorsal view; **F**₂, ventral view; **G**, *Tinospora uviforme* (Baill.) Thanikaimoni, *H. Humbert* 12364; **G**₁, dorsal view; **G**₂, ventral view; **G**₃, transverse section; **H**, *Triclisia dictyophylla* Diels, *R. Letouzey* 5282; **H**₁, lateral view; **H**₂, dorsal view; **H**₃, sagittal section; **I**, *Triclisia loucoubensis* Baill., *Pervillé s.n.*; **I**₁, lateral view; **I**₂, dorsal view; **I**₃, sagittal section; **J**, *Triclisia sacleuxii* (Pierre) Diels, Reid collection; **J**₁, lateral view; **J**₂, dorsal view. Scale bars: 2 mm.

Tinospora uviforme (Baill.) Thanikaimoni
(Fig. 13G)

MATERIAL EXAMINED. — Madagascar. Mandara, Anadabolava, *H. Humbert 12364* (P).

DESCRIPTION

Endocarp straight, rounded in outline with a ventral condyle; one dorsal ridge, a few inconspicuous lateral ridges; keeled at apex, obtuse at base; ornamented surface with high and reticulated walls; simple intrusive condyle without protruding chamber, small aperture 1.1 mm long and 0.5 mm wide. Length, 9.8 mm; width, 9.1 mm; thickness, 7.3 mm.

55. Genus *Triclisia* Benth.

Triclisia dictyophylla Diels
(Fig. 13H)

MATERIAL EXAMINED. — Cameroon. Yokadouma, *R. Letouzey 5282* (P).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; one inconspicuous dorsal ridge, no lateral ridges; surface ornamented with numerous strong and short walls; rugose surface; limbs ending comma-shaped with the thinner one keeled; double intrusive lateral condyle. Length, 15.5 mm; width, 11.1 mm; thickness, 8.3 mm.

Triclisia loucoubensis Baill.
(Fig. 13I)

MATERIAL EXAMINED. — Madagascar. *Pervillé s.n.* (P).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; one high dorsal ridge, one to two inconspicuous lateral ridges; surface slightly reticulated; limbs ending comma-shaped, with the bigger one keeled, limbs quite short; double intrusive lateral condyle. Length, 11.3 mm; width, 9.0 mm; thickness, 6.9 mm.

Triclisia sacleuxii (Pierre) Diels
(Fig. 13J)

MATERIAL EXAMINED. — Unknown origin, collector unknown (Reid collection, BM).

DESCRIPTION

Endocarp hairpin-shaped, elliptic in outline; one dorsal ridge, some buboes on the surface more or less aligned on lateral lines; rugose surface; one limb bigger than the other; double intrusive lateral condyle. Length, 11.4 mm; width, 8.5 mm; thickness, 6.1 mm.

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