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A systematic account of the genus *Plagiostoma* (*Gnomoniaceae*, *Diaporthales*) based on morphology, host-associations, and a four-gene phylogeny

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Abstract: Members of the genus *Plagiostoma* inhabit leaves, stems, twigs, and branches of woody and herbaceous plants predominantly in the temperate Northern Hemisphere. An account of all known species of *Plagiostoma* including *Cryptodiaporthe* is presented based on analyses of morphological, cultural, and DNA sequence data. Multigene phylogenetic analyses of DNA sequences from four genes (*β-tubulin*, ITS, *rpb2*, and *tef1-α*) revealed eight previously undescribed phylogenetic species and an association between a clade composed of 11 species of *Plagiostoma* and the host family *Salicaceae*. In this paper these eight new species of *Plagiostoma* are described, four species are redescribed, and four new combinations are proposed. A key to the 25 accepted species of *Plagiostoma* based on host, shape, and size of perithecia, perithecial arrangement in the host, and microscopic characteristics of the asci and ascospores is provided. Disposition of additional names in *Cryptodiaporthe* and *Plagiostoma* is also discussed.

Key words: *Ascomycota*, *Betulaceae*, epitypification, *Fraxinus*, new species, phylogeny, *Salicaceae*, *Sordariomycetidae*.
Taxonomic novelties: *Plagiostoma dilatatum* L.C. Mejía, sp. nov., *Plagiostoma exstocollum* L.C. Mejía, sp. nov., *Plagiostoma imperceptibile* L.C. Mejía, sp. nov., *Plagiostoma oregonense* L.C. Mejía, sp. nov., *Plagiostoma ovalisporum* L.C. Mejía, sp. nov., *Plagiostoma samuelsii* L.C. Mejía, sp. nov., *Plagiostoma versatile* L.C. Mejía & Sogonov, sp. nov., *Plagiostoma yunnanense* L.C. Mejía & Zhu L. Yang, sp. nov., *Plagiostoma apiculatum* (Wallr.) L.C. Mejía, comb. nov., *Plagiostoma convexum* (Preuss) L.C. Mejía, comb. nov., *Plagiostoma populinum* (Fuckel) L.C. Mejía, comb. nov., *Plagiostoma pulchellum* (Sacc. & Briard) L.C. Mejía, comb. nov.

INTRODUCTION

The genus *Plagiostoma* (*Gnomoniaceae, Diaporthales*) includes microscopic fungi that inhabit the leaves, stems, twigs, and branches of woody and herbaceous plants from a range of families including the *Betulaceae, Euphorbiaceae, Geraniaceae, Hippocastanaceae, Oleaceae, Polygonaceae, Salicaceae, Sapindaceae,* and *Staphylaceae* in temperate regions of the Northern Hemisphere (Sogonov *et al.* 2008). Although some species of *Plagiostoma* cause diseases, most do not show symptoms prior to production of perithecia on dead tissues. Described by Fuckel (1870), the morphological concept of *Plagiostoma* remained relatively unchanged (Barr 1978, Monod 1983) until recently. Multigene phylogenetic studies suggest that the genus *Plagiostoma* forms a highly supported monophyletic clade that includes the type species of *Plagiostoma*, *P. euphorbiae,* and the type species of *Cryptodiaporthe*, *C. aesculi,* among others (Mejía *et al.* 2008, Sogonov *et al.* 2008). Sogonov *et al.* (2008) included 13 species in the genus *Plagiostoma,* several of which were previously placed in *Cryptodiaporthe.*

A brief historical account of the major taxonomic treatments of *Plagiostoma* and *Cryptodiaporthe* illustrates the views of these genera through time. Fuckel (1870) proposed the genus *Plagiostoma* for sphaericeaous species characterised by flattened perithecia oriented horizontally having short, lateral, erumpent necks. Fuckel (1870) included the genera *Ceratostoma, Gnomonia*, *Linospora*, *Melanospora,* and *Rhaphidospora* together with *Plagiostoma* in the tribe *Ceratostomeae* of the *Sphaeriacei*. In his original description of *Plagiostoma*, Fuckel (1870) included four species, *P. euphorbiae*, *P. petiolicola*, *P devexum*, and *P. suspecta*. Fuckel's concept of *Plagiostoma* was followed by Höhnel (1917) and von Arx (1951) who, like Fuckel, considered *Plagiostoma* to be relatively closely related to *Gnomonia*, the name on which the *Gnomoniaceae* is based. These authors differentiated *Gnomonia* from *Plagiostoma* mainly by orientation of the perithecial neck. *Gnomonia* was characterised by having central, upright, perithecial necks in contrast to species of *Plagiostoma* with eccentric, laterally oriented, perithecial necks. In her treatment of the order *Diaporthales*, Barr (1978) followed Fuckel's concept of *Plagiostoma* and placed *Gnomonia* and *Plagiostoma* in the same suborder *Gnomoniineae* but in different families, *i.e. Gnomonia* in the *Gnomoniaceae* and *Plagiostoma* in the *Valsaceae*. The *Valsaceae* was defined based on having "beaks oblique or lateral, erumpent separately or converging through stromatic disc" (Barr, 1978 p. 15). Barr (1978) made nine new combinations in *Plagiostoma* expanding the number of species in the genus to 13.

In his monograph of the *Gnomoniaceae*, Monod (1983) accepted most species treated by Barr (1978). However, Monod considered that the typification of *Plagiostoma* as *P. euphorbiae* by Höhnel (1917) was not representative of *Plagiostoma* because the perithecial necks of this species are eccentric rather than lateral as stipulated by Fuckel (1870). Monod (1983) transferred *P. euphorbiae* to the genus *Gnomonia* and re-typified *Plagiostoma* with *P. devexum*. In agreement with Barr (1991) and Sogonov *et al.* (2008) the typification of the genus *Plagiostoma* with *P. euphorbiae* by Höhnel (1917) is accepted here because this typification predates Monod (1983) and is in accordance with Article 10 of the International Code of Botanical Nomenclature (McNeill *et al.* 2006).

Table 1. Isolates with sequences included in the phylogenetic analysis of *Plagiostoma*. Types and epitypes are indicated in bold.

Taxon	Specimen	Culture	Country	Host	Collector	*β-tubulin*	ITS	rpb2	tef1-α
Apiognomonia hystrix	CBS-H 11343	CBS 911.79	Switzerland	*Acer pseudoplatanus*	M. Monod	GU366973	DQ313549	EU219260	GU353957
Apiognomonia veneta	NA	CBS 897.79	Switzerland	*Platanus orientalis*	M. Monod	GU377974	DQ313532	EU219259	GU353958
Plagiostoma aesculi	BPI 748430	CBS 109765	Austria	*Aesculus hippocastaneum*	W. Jaklitsch	GU367021	DQ323530	EU199138	GU354004
	BPI 878950	CBS 126127 (= LCM 447.01)	Germany	*Aesculus hippocastaneum*	L.C. Mejía	GU367019	GU367076	GU367110	GU354002
	BPI 878950	LCM 447b.01	Germany	*Aesculus hippocastaneum*	L.C. Mejía	GU367020	GU367077	GU367111	GU354003
	BPI 840942	CBS 121905	Austria	*Aesculus hippocastaneum*	W. Jaklitsch	GU367022	EU254994	EU219269	GU354005
Plagiostoma amygdalinae	NA	CBS 791.79	Switzerland	*Euphorbia amygdaloides*	M. Monod	GU367030	EU254995	GU367113	GU354012
Plagiostoma apiculatum	BPI 747938	CBS 109775 (= AR 3455)	Austria	*Salix* sp.	W. Jaklitsch	GU367008	DQ323529	EU199141	GU353990
	BPI 878951	LCM 393.01	France	*Salix dasyclados*	L.C. Mejía	GU367010	GU367067	GU367101	GU353992
	BPI 878952	CBS 126126 (= LCM 436.01)	USA: WA	*Salix sitchensis*	L.C. Mejía	GU367009	GU367066	GU367100	GU353991
Plagiostoma barriae	BPI 878954	LCM 601.01	USA: WA	*Acer macrophyllum*	L.C. Mejía	GU366996	GU367054	GU367091	GU353980
Plagiostoma convexum	BPI 843490	CBS 123206	USA: NY	*Salix* sp.	L. Vasilyeva	GU367011	EU255047	-	GU353994
Plagiostoma devexum	BPI 843489	CBS 123201	USA: NY	*Polygonum* sp.	L. Vasilyeva	GU367027	EU255001	EU219258	GU354010
Plagiostoma dilatatum	BPI 878957	CBS 124976 (= LCM 402.02)	France	*Salix irrorata*	L.C. Mejía	GU367013	GU367070	GU367104	GU353996
	BPI 878958	LCM 403.02	France	*Salix caprea*	L.C. Mejía	GU367012	GU367069	GU367103	GU353995
Plagiostoma euphorbiaceum	NA	CBS 816.79	Switzerland	*Euphorbia palustris*	M. Monod	GU367031	EU255003	-	GU354013
Plagiostoma euphorbiae	NA	CBS 340.78	The Netherlands	*Euphorbia palustris*	W. Gams	GU367034	DQ323532	EU219292	GU354016
Plagiostoma exstocollum	BPI 878961	CBS 127662 (= LCM 468.01)	USA: OR	*Corylus californica*	L.C. Mejía	GU366988	GU367046	GU367086	GU353972
	BPI 878959	LCM 422.01	USA: OR	*Corylus californica*	L.C. Mejía	GU366985	GU367043	GU367085	GU353969
Plagiostoma fraxini	BPI 746412	CBS 109498	USA: MD	*Fraxinus pennsylvanica*	S. Redlin	GU367033	AY455810	EU219263	GU354015
Plagiostoma geranii	NA	CBS 824.79	Switzerland	*Geranium sylvaticum*	M. Monod	GU367032	EU255009	EU219273	GU354014
Plagiostoma imperceptibile	BPI 878967	LCM 456.01	USA: CA	*Salix* sp.	L.C. Mejía	GU367002	GU367059	GU367094	GU353984
Plagiostoma oregonense	BPI 878968	CBS 126124 (= LCM 597.01)	USA: OR	*Salix* sp.	L.C. Mejía	GU367016	GU367073	GU367107	GU353999
Plagiostoma ovalisporum	BPI 878969	CBS 124977 (= LCM 458.01)	USA: ID	*Salix* sp.	L.C. Mejía	GU367015	GU367072	GU367106	GU353998
Plagiostoma petiolophilum	BPI 878970	CBS 126123 (= LCM 181.01)	USA: NY	*Acer spicatum*	L.C. Mejía	GU367023	GU367078	GU367112	GU354006
	BPI 863769	AR 3821	USA: NY	Acer sp.	L. Vasilyeva	GU367025	EU255039	EU219257	GU354008
Plagiostoma populinum	NA	CBS 144.57	The Netherlands	*Populus trichocarpa*	B. Gerrits van den Ende	GU367018	GU367075	GU367109	GU354001
	NA	CBS 174.58	The Netherlands	*Populus canadensis*	B. Gerrits van den Ende	GU367017	GU367074	GU367108	GU354000
Plagiostoma pulchellum	BPI 878971	CBS 126653 (= LCM 365.04)	USA: MD	*Salix babylonica*	L.C. Mejía	GU367006	GU367063	GU367098	GU353987
	BPI 878972	LCM 371.02	USA: MD	*Salix babylonica*	L.C. Mejía	GU367007	GU367064	GU367099	GU353988
	BPI 878973	LCM 438.04	USA: WA	*Salix lucida*	L.C. Mejía	GU366004	GU367061	GU367096	GU353985
	BPI 878974	LCM 623.01	Argentina	*Salix humboldtiana*	L.C. Mejía	GU367005	GU367062	GU367097	GU353986
	NA	CBS 170.69	The Netherlands	*Populus balsamifera*	Unknown	-	EU255043	-	GU353989
Plagiostoma rhododendri	NA	CBS 847.79	Switzerland	*Rhododendron hirsutum*	M. Monod	GU367026	EU255044	EU2192578	GU354009
Plagiostoma robergeanum	BPI 843593	CBS 121472	Austria	*Staphylea pinnata*	W. Jaklitsch	GU367029	EU255046	EU219262	GU354011
Plagiostoma salicellum	BPI 843527	CBS 121466 (= AR 3828)	Austria	*Salix alba*	W. Jaklitsch	GU366978	EU254996	EU219278	GU353962
	BPI 878975	CBS 126121 (= LCM 449.01)	Germany	*Salix repens*	L.C. Mejía	GU366977	GU367037	GU367081	GU353961
Plagiostoma samuelsii	BPI 878977	CBS 125668 (= LCM 454.04)	USA: CA	*Alnus tenuifolia*	L.C. Mejía	GU366993	GU367051	GU367089	GU353977
	BPI 878979	LCM 596.01	USA: WA	*Alnus* sp.	L.C. Mejía	GU366994	GU367052	GU367090	GU353978
Plagiostoma versatile	BPI 878980	CBS 124978 (= LCM 594.01)	USA: WA	*Salix scouleriana*	L.C. Mejía	GU366979	GU367038	GU367082	GU393963
	BPI 878981	LCM 595.01	USA: WA	*Salix scouleriana*	L.C. Mejía	GU366980	GU367039	GU367083	GU393964
	BPI 878982	LCM 598.01	USA: OR	*Salix* sp.	L.C. Mejía	GU366981	GU367040	GU367084	GU393965
	BPI 877702	CBS 121251	Canada	*Salix* sp.	M.V. Sogonov	GU366982	EU255059	EU219268	GU393966