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Anatomical Comparison of Claspers of Freshwater Stingrays (Dasyatidae and Potamotrygonidae)

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Abstract Claspers of four species of freshwater stingrays, which belong to the genera *Dasyatis* (Dasyatidae), *Paratrygon* and *Potamotrygon* (Potamotrygonidae), are examined to reveal differences in the clasper structure among these genera. The relationships of freshwater stingrays are discussed based on our examination of the clasper structures as well as that reported in recent literature for two other genera of freshwater stingrays, *Himantura* (Dasyatidae) and *Plesiotrygon* (Potamotrygonidae).

It has been known that two major groups of stingrays occur in rivers and lakes in tropical and subtropical regions. The family Potamotrygonidae, one of the two freshwater stingray groups, is restricted to the river systems of tropical South America. This family consists of three genera, *Paratrygon*, *Plesiotrygon* and *Potamotrygon* (Rosa et al., 1987). Some species of the family Dasyatidae are another group of stingrays in the freshwater. Although Hamilton-Buchanan (1822) recorded two species of *Raia* (most probably *Dasyatis*) far up in the Ganges River, *Trygon* (=*Dasyatis*) *ukpam* Smith, 1863 in tropical West Africa was the first virtually recorded freshwater Dasyatidae in the world. Since then, the freshwater Dasyatidae has frequently been described by many authors: *Dasyatis fluviorum* Ogilby (1908) from Australia, *Himantura krempfi* (Chabanaud, 1923) from Southeast Asia, *D. garouaensis* (Stauch and Blanc, 1962) from West Africa which was first erroneously assigned to the genus *Potamotrygon*, *H. signifer* Campagno and Roberts, 1982, from Southeast Asia and *D. laosensis* Roberts and Karnasuta, 1987, from Southeast Asia.

Although there have been studies concerning the clasper structure of skates, family Rajidae (e.g., Petri, 1878; Jungersen, 1899; Leigh-Sharpe, 1920–26; Ishiyama, 1958; Stehmann, 1970; Hulley, 1972), there were few studies on the clasper structure of stingrays until La Marca (1964) described it for *Urolophus jamaicensis.* Subsequently, descriptions and terminology for the clasper structure of stingrays were published by Capapé and Desoutter (1978, 1979), Compagno and Roberts (1982), Capapé (1983) and Rosa et al. (1987).

From 1976 to 1985, some members of the Japanese Society for Elasmobranch Studies conducted surveys of the freshwater stingrays in Southeast Asia, South America and West Africa. In those surveys, clasper samples were obtained of three genera of freshwater stingrays, viz., *Dasyatis, Paratrygon* and *Potamotrygon.* In this study the clasper structures of those stingrays are described and compared with those of other freshwater stingrays, viz., *Himantura signifer* Compagno and Roberts, 1982 and *Plesiotrygon iwamae* Rosa et al., 1987.

Materials and methods

Specimens used in the present study are: *Paratrygon aiereba,* adult male, FUMT(Department of Fisheries, University Museum, University of Tokyo)-P 10849, 508 mm DW (disc width), collected from the Amazon Basin near Manaus, Brazil, Sept. 9, 1980; *Potamotrygon motoro,* adult male, FUMT-P10853, 290 mm DW, collected near Santa Fe, Dec., 1980; immature male, FUMT-P10846, 275 mm DW, collected near Manaus, Sept. 9, 1980; *Potamotrygon orbignyi,* three adult males, FUMT-P10843, 10844, 10845, 162 mm DW, 172 mm DW, 180 mm DW, collected from Iquitos, May, 1985; *Dasyatis garouaensis,* adult male, FUMT-P10848, 281 mm DW, collected from the Sanaga Basin, Dec. 18, 1985.

The clasper skeletons were observed without staining. Nomenclature of the species of the family Potamotrygonidae follows Rosa (1985). Terminology of the clasper follows Compagno and Roberts (1982) and Rosa et al. (1987) with the following exceptions: the dorsal terminal of Compagno and Roberts (1982) and dorsal terminal 1 of Rosa et al. (1987) are here designated as dorsal terminal 2 be-

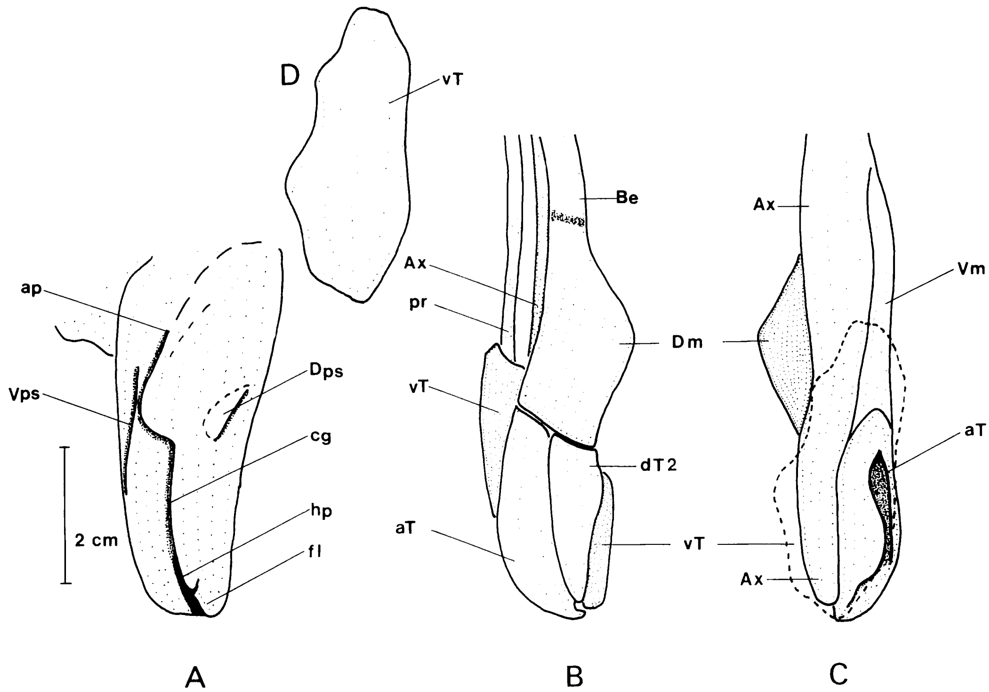

Fig. 1. Clasper of *Paratrygon aiereba*, FUMT-P10849, 508 mm DW, from near Manaus. A, left clasper; B, dorsal view of clasper skeleton; C, ventral view of clasper skeleton; D, ventral terminal. ap, apopyle; aT, accessory terminal; Ax, axial cartilage; Be, beta cartilage; cg, clasper groove; Dm, dorsal marginal; Dps, dorsal pseudosiphon; dT2, dorsal terminal 2; fl, flap; hp, hypopyle; pr, pelvic radial; Vm, ventral marginal; Vps, ventral pseudosiphon; vT, ventral terminal.

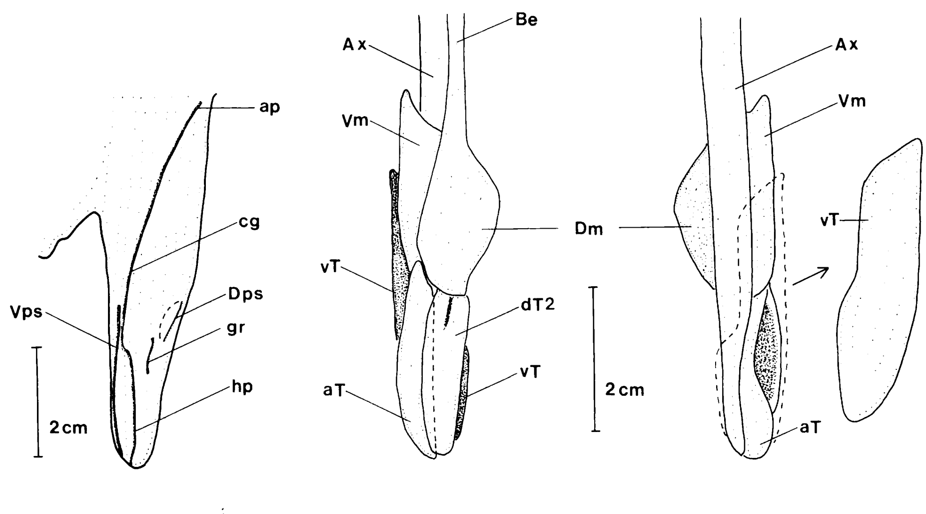

Fig. 2. Clasper of *Potamotrygon motoro*, FUMT-P10853, 290 mm DW, from near Santa Fe. A, left clasper; B, dorsal view of clasper skeleton; C, ventral view of clasper skeleton. gr, groove. Other abbreviations same as in Fig. 1.

cause of the following two reasons. The term of dorsal terminal 1 should be used for the cartilage covering the dorsal side of the glans clasper and there are two dorsal terminal cartilages other than dorsal terminal 1 in a stingray, *Myliobatis cervus* (=*M. aquila*) (see Hulley, 1972); the ventral terminal of Compagno and Roberts (1982) and dorsal terminal 2 of Rosa et al. (1987) are here called accessory terminal, because the cartilage is articulated with the ventral marginal; the ventral covering piece of both authors is here designated as ventral terminal, because the cartilage entirely covers the ventral side of the glans clasper. An additional discrepancy in terminology for clasper components exists between those authors. Pseudopera of Compagno and Roberts (1982) was called ventral pseudosiphon by Rosa et al. (1987). The present authors agree to use the term of ventral pseudosiphon of the latter authors, because the pseudopera is a component of the clasper of sharks.

Description

Measurements used in this study are given in Table 1.

Clasper of *Paratrygon aiereba* (Fig. 1): depressed, stiff with rounded tip, its length from distal end of cloaca 18.6% of DW; clasper groove beginning far anterior to the level of posterior margin of pelvics; anterior half of the groove running obliquely toward midline and then curving inward; posterior half running almost along midline; dorsal pseudosiphon well developed near inner edge and obliquely oriented, its length 10.6% of clasper length; ventral pseudosiphon also well developed near outer lateral edge; distal part of clasper groove forming flap-like component.

Glans clasper skeleton consists of dorsal marginal, ventral marginal, dorsal terminal 2, accessory terminal, ventral terminal and axial cartilages. Basal part of skeleton consists of basipterygium, two basal (b1 and b2) segments and a single beta-cartilage. Dorsal terminal 2 long and oval-shaped; dorsal marginal broad and trapezoid; outer edges of dorsal marginal and dorsal terminal 2 forming clasper groove externally; inner edge of posterior part of dorsal marginal forming dorsal pseudosiphon externally; ventral terminal large and oval-rectangular; ventral marginal long, narrow and rod-like, proximally united with a pelvic radial; accessory terminal domed, long and fusiform; outer edge of accessory terminal forming ventral pseudosiphon externally; axial with rounded distal tip; b1 segment connecting basipterygium and b2 segment which is linked with the proximal part of axial; beta-cartilage originating at b1 segment and distally articulated with dorsal marginal.

Clasper of *Potamotrygon motoro* (Fig. 2): moderately wide and depressed, its length 33.2% of DW; clasper groove beginning far proximally to the level of posterior margin of pelvics; the groove running obliquely from medial edge to lateral edge and then curving inward at the level of posterior margin of dorsal pseudosiphon; dorsal pseudosiphon well developed and slightly oblique to midline, its length 9.0% of clasper length; ventral pseudosiphon also well developed at lateral edge; another groove-like component present between dorsal and ventral pseudosiphons.

Glans clasper skeleton consists of dorsal marginal, ventral marginal, dorsal terminal 2, accessory terminal, ventral terminal and axial cartilages. Basal part of skeleton consists of basipterygium, two basal (b1 and b2) segments and a single beta-cartilage. Dorsal terminal 2 trapezoid, broad and oval, with a groove present along proximal center of the cartilage; outer edges of dorsal marginal and dorsal terminal 2 forming clasper groove externally; inner edge of posterior part of dortsal marginal forming dorsal pseudosiphon externally; ventral terminal large and oval-

Table 1. Measurements (mm) of the claspers of the four freshwater stingrays in the present study. Numbers in parentheses are those in % of the clasper length. DW, disc width.

	Paratrygon aiereba FUMT-P10849 508 mm DW	*Potamotrygon motoro* FUMT-P10853 290 mm DW	*Potamotrygon orbignyi* FUMT-P10844 172 mm DW	*Dasyatis garouaensis* FUMT-P10848 281 mm DW
Clasper length from distal margin of cloaca	94.6(100)	96.3(100)	39.8(100)	59.3(100)
Clasper length from end of pelvics	42.3(44.7)	48.3(50.2)	27.0(67.8)	30.3(51.1)
Width at end of pelvics	23.5(24.8)	19.6(20.4)	8.4(21.2)	10.7(18.0)
Length of dorsal pseudosiphon	10.0(10.6)	8.7(9.0)	4.9(12.3)	8.1(13.7)
Length of ventral pseudosiphon	31.9(33.7)	31.0(32.2)	18.6(46.7)	18.6(31.4)

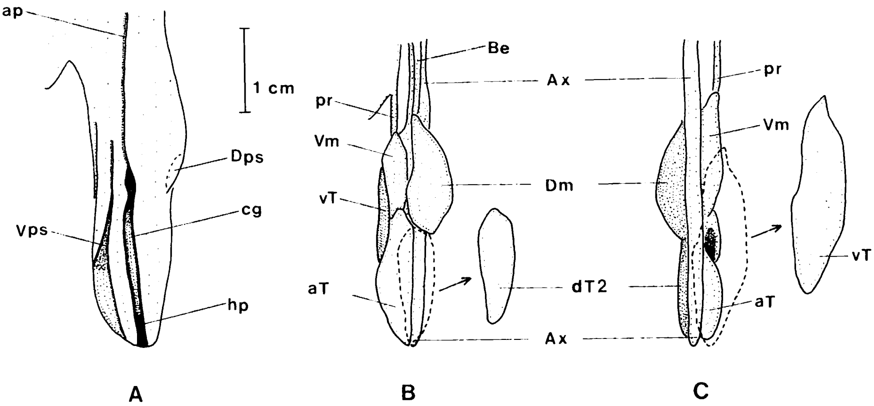

Fig. 3. Clasper of *Potamotrygon orbignyi*, FUMT-P10844, 172 mm DW, from Iquitos. A, left clasper; B, dorsal view of clasper skeleton; C, ventral view of clasper skeleton. Abbreviations same as in Fig. 1.

rectangular; ventral marginal long and narrow with pointed proximal tip; accessory terminal domed and fusiform; dorsally the cartilage partially underlies dorsal terminal 2; outer edge of accessory terminal forming ventral pseudosiphon externally; axial gradually tapering to distal tip; b1 segment connecting basipterygium and b2 segment which is linked with proximal part of axial; beta-cartilage originating at the b1 segment and distally articulated with dorsal marginal.

Clasper of *Potamotrygon orbignyi* (Fig. 3): depressed, rather thin with rounded distal tip, its length 23.1–29.6% of DW; clasper groove beginning slightly anterior to the level of posterior margin of pelvics; the groove entirely running along midline; dorsal pseudosiphon small, hidden below medial expansion of the dorsal marginal cartilage, its length 12.3% of clasper length; ventral pseudosiphon well developed near outer lateral edge.

Glans clasper skeleton consists of dorsal marginal, ventral marginal, dorsal terminal 2, accessory terminal, ventral terminal and axial cartilages. Basal part of skeleton consists of basipterygium, only one basal segment and a single beta-cartilage. Dorsal terminal 2 long and oval-shaped; dorsal marginal trapezoid and broad; outer edges of dorsal marginal and dorsal terminal 2 forming clasper groove externally; inner distal edge of dorsal marginal forming dorsal pseudosiphon externally; ventral terminal long and oval-rectangular in shape; ventral marginal rod-like, proximally united with pelvic radial and distally with accessory terminal; accessory terminal domed and half oval-shaped; outer edge of accessory terminal forming ventral pseudosiphon externally; axial thin and long with blunt distal tip; basal segment connecting basipterygium and axial; beta-cartilage orginating at basal segment and distally not fused but articulated to the dorsal marginal.

Clasper of *Dasyatis garouaensis* (Fig. 4): depressed, moderately broad with rounded tip, its length 21.1% of DW; clasper groove beginning far anterior to the level of posterior margin of pelvics, running almost straight along outer lateral edge and abruptly curving inward at the level of posterior margin of dorsal pseudosiphon; dorsal pseudosiphon small, its length 13.7% of clasper length; ventral pseudosiphon well developed near outer lateral edge.

Glans clasper skeleton consists of dorsal marginal, ventral marginal, dorsal terminal 2, accessory terminal, ventral terminal and axial cartilages. Basal part of skeleton consists of basipterygium, three basal (b1, b2 and b3) segments and a single beta-cartilage. Dorsal terminal 2 boot-shaped, with proximal part partially overlapping dorsal marginal; dorsal marginal broadly trapezoid; outer edges of dorsal marginal and dorsal terminal 2 forming clasper groove externally; inner edge of posterior part of dorsal marginal forming dorsal pseudosiphon externally; ventral terminal large and trapezoid; ventral marginal long and rod-like; accessory terminal domed and oval-shaped; half of dorsal side of accessory terminal overlapping dorsal terminal; outer edge of accessory terminal forming ventral pseudosiphon externally; distal part of axial curved with rounded tip; three basal segments connecting basipterygium and axial; beta-cartilage originating at b1 segmernt and distally not

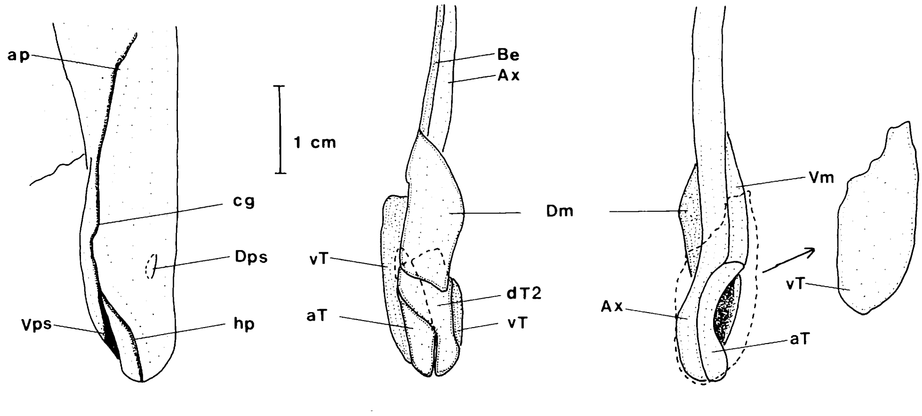

Fig. 4. Clasper of *Dasyatis garouaensis*, FUMT-P10848, 281 mm DW, from Sanaga Basin. A, left clasper; B, dosal view of clasper skeleton; C, ventral view of clasper skeleton. Abbreviations same as in Fig. 1.

fused but articulated to dorsal marginal.

Comparison of claspers

External appearance: Claspers of the four species in the present study and those of *Plesiotrygon iwamae* Rosa et al., 1987 and *Himantura signifer* Compagno and Roberts, 1982 have both dorsal and ventral pseudosiphons which are similar in shape. In the clasper of *P. motoro*, a groove is present between dorsal and ventral pseudosiphons, which is unique among the claspers of the six species.

Marginal, terminal and axial cartilages: The trapezoid-shaped dorsal marginal is similar in all six species. Dorsal terminal 2 is long and oval-shaped in the four species of the Potamotrygonidae; it is boot-shaped in *D. garouaensis* and *H. signifer*. A groove is only present at the center of dorsal terminal 2 in *P. motoro*. The shape of the ventral terminal is long and oval-rectangular in the four species of the Potamotrygonidae and *H. signifer*; in *D. garouaensis* it is half oval-shaped. The proximal tip of the ventral marginal is pointed in *P. orbignyi* and *P. motoro* but proximally tepering in *P. aiereba*, *P. iwamae*, *D. garouaensis* and *H. signifer*. The shape of the accessory terminal is similar in the claspers of all six species. The beta-cartilage and dorsal marginal are firmly fused in the claspers of *P. aiereba*, *P. motoro*, and *H. signifer* but only loosely connected in *P. orbignyi*, *P. iwamae*, and *D. garouaensis*.

Number of basal segments: One in *P. orbignyi*, two in *P. aiereba*, *P. motoro*, *P. iwamae*, and *H. signifer* and three in *D. garouaensis* (see also Table 2).

We found only slight differences among the clasper cartilages of the six species in the shape of dorsal terminal 2, which is long and oval-shaped in the four species of the Potamotrygonidae and boot-shaped in the two species of the Dasyatidae. Although other differences are found in the clasper cartilages of the species, they should be regarded as only an infrageneric or infrafamilial variation. The number of the basal segments varies from one to three in the six species. We also observed a great deal of variability from our unpublished studies on other species of stingrays, as well as from the literature (see Table 2). Ishiyama (1958) and Hulley (1972) believed that the number of the basal segments is significant for stating the phylogenetic relationships among skates and rays, because it is two in the family Rajidae, three in the Rhinobatidae and four in the Platyrhinidae. Our findings, however, show that it varies even within *Dasyatis* and *Potamotrygon*.

Incorporating all the evidences, no major difference is found in the claspers of the three genera of the Potamotrygonidae, and nor any between the claspers of the freshwater Dasyatidae and Potamotrygonidae. Morphologically the anteriorly directed prepelvic process in the latter family only distinguishes the two families (Thorson and Watson, 1975). In conclusion, there is no significant difference in the claspers among the three genera of the Potamotrygonidae. Furthermore, the claspers of the freshwater Dasyatidae differ only slightly from those of the Potamotrygonidae, and they may not be useful

Table 2. Number of basal segments in the claspers of the order Myliobatiformes.

Species	Number	Source
Potamotrygonidae		
Paratrygon aiereba	2	present study
	1	Garman (1913)
Plesiotrygon iwamae	2	Rosa et al. (1987)
Potamotrygon constellata	2	Ishihara, unpublished
(= *P. circularis*)	1	Garman (1913)
Potamotrygon orbignyi	1	present study
Potamotrygon falkneri	2	Ishihara, unpublished
Potamotrygon motoro	2	present study
Dasyatidae		
Dasyatis garouaensis	3	present study
Dasyatis akajei	2	Ishihara, unpublished
Dasyatis centroura	2	Garman (1913)
(= *Dasybatus marinus*)		
Dasyatis kuhlii	1	Ishihara, unpublished
Dasyatis violacea	2	Jungersen (1899); Ishihara, unpublished
Himantura signifer	2	Compagno and Roberts (1982)
Taeniura lymma	1	Garman (1913)
Gymuridae		
Gymnura altavela	2	Garman (1913)
Urolophidae		
Urolophus aurantiacus	2	Ishihara, unpublished
Urolophus jamaicensis	2	Garman (1913); La Marca (1964)
(= *Urobatis sloani*)		
Myliobatidae		
Aetobatus narinari	2	Garman (1913)
Myliobatis freminvillii	2	Garman (1913)
Rhinopteridae		
Rhinoptera brasiliensis	1	Garman (1913)
(= *R. jussieui*)		
Mobulidae		
Mobula hypostoma	3	Garman (1913)

to assess phylogenetic relationships between the claspers of Potamotrygonidae and freshwater Dasyatidae, when compared with the difference among the claspers of the families Rhinobatidae, Platyrhinidae and Rajidae (see Ishiyama, 1958: figs. 2 plus 7 and 20, and remarks above on the number of the basal segments).

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淡水産エイ類4種の交接器の比較

谷内　透・石原　元

淡水産エイ類の内，アカエイ属 *Dasyatis*（アカエイ科）に属する *D. garouaensis* と，*Paratrygon* に属する *P. aiereba*, *Potamotrygon* に属する *P. motoro* と *P. orbignyi*（いずれもポタモトリゴン科）の交接器の相違点を明らかにする目的で比較検討を行った．交接器を構成する軟骨の名称については，混乱が多いので正確に定義を行った．これら4種の交接器の観察結果に，他の淡水産エイ類の2種，オトメエイ属の *Himantura signifer*（アカエイ科）と *Plesiotrygon* に属する *P. iwamae*（ポタモトリゴン科）の交接器に関する文献資料を加え，これら2科5属の淡水産エイ類の類縁関係を交接器の形態から考察した．その結果，属間のみならず科間でも交接器の構造に際だった差異は認められなかった．サカタザメ科，ウチワザメ科，ガンギエイ科（ガンギエイ目）では交接器が相違することに比較すると，これら2科（トビエイ目）の類縁関係を考究するのに交接器は不向きであることが明らかとなった．

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