A Review On Medicinal Uses, Phytochemistry And Pharmacological Activities Of The Genus Astripomoea (Convolvulaceae)

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Abstract: The genus Astripomoea A. Meeuse (Convolvulaceae) comprises 12 species with its centre of diversity in East Africa. Some of the species are widely used as traditional medicines. Therefore, this study aims at providing comprehensive information on the medicinal uses, phytochemical and pharmacological properties of Astripomoea species. Electronic databases, including Web of Science, Science Direct, Google Scholar, Scopus, PubMed, and Springer Link were used as information sources. Additional information was obtained from pre-electronic sources such as books, book chapters, scientific journals and other grey literature obtained from the University library. Astripomoea grantii, A. lachnosperma, A. malvacea and A. rotundata were identified as the most frequently used members of the genus as sources of traditional medicines. The aerial parts, flower sap, leaf sap, leaf smoke, leaf and root infusion or decoction of A. grantii, A. lachnosperma, A. malvacea and A. rotundata are mainly used to induce labour and as ethnoveterinary medicine, and traditional medicine for abdominal pains, constipation, cough, eye problems, inflammation, madness, malaria and swellings. The aliphatic tropine, nor-tropine esters and the alkaloid astrimalvine A N-oxide have been isolated from the root bark of A. malvacea. Some species of Astripomoea such as A. grantii and A. malvacea exhibited pharmacological activities such as antibacterial, antifungal and antiviral activities. The genus Astripomoea is a valuable source of bioactive phytochemical compounds with therapeutic potential in different diseases. More and broader ethnopharmacological studies are therefore, needed to provide further evidence of the health benefits associated with Astripomoea species.

Keywords: Astripomoea grantii, Astripomoea lachnosperma, Astripomoea malvacea, Astripomoea rotundata, Asteraceae, Convolvulaceae, herbal medicine, indigenous knowledge, southern Africa

1 INTRODUCTION

The genus Astripomoea A. Meeuse belongs to the Convolvulaceae, morning glory or bindweed family. The Convolvulaceae family consist of approximately 1880 species and 57 genera, mostly perennial herbaceous vines, but also annual herbs, shrubs and trees that are endemic to the tropical regions and recorded as weedy species in temperate regions [1-3]. The tuberous roots of some members of the Convolvulaceae family such as Ipomoea batatas (L.) Lam. (sweet potato) are used as food plants and regarded as the world's second most important root crop [2,4]. Some members of the Convolvulaceae family such as Ipomoea batatas, Merremia tridentata (L.) Hall. f., Evolvulus alsinoides (L.) L., Argyreia nervosa (Burm. f.) Bojer, Ipomoea mauritiana Jacq., Evolvulus nummularius (L.) L., Convolvulus arvensis L., Convolvulus althaeoides L., Convolvulus lineatus L., Convolvulus pilosellifolius Desr., Convolvulus prostratus Forssk, Argyreia cuneata Ker Gawl. and Ipomoea carnea Jacq. are characterized by antimicrobial, antioxidant, hypoglycemic, hypocholesterolemic, anticancer, hypotriglyceridemic, antidiabetic and wound healing properties [5-7]. These species and other members of the Convolvulaceae family are also characterized by several phytochemical compounds such as quinones, alkaloids, cardiac glycosides, unsaturated sterols, resin, lactones, flavonoids, tannins, saponins, terpenoids, phenolics and steroids [8-13]. The genus Astripomoea comprises comprises 12 species with its centre of diversity in East Africa, and one species, A. malvacea (Klotzsch) A. Meeuse extending to the Arabian Peninsula [14].

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Astripomoea hyoscyamoides (Vatke) Verdc. has been recorded as a weed of pastures in Tanzania and Zimbabwe while A. malvacea has been recorded as a weed in Botswana [15,16]. The genus name Astripomoea is derived from the Greek word "Astri", meaning "star-like"and the genus Ipomoea L., in reference to the starry pubescence and trailing habit of the Astripomoea species [17,18]. Some species belonging to the genus Astripomoea have been used as traditional medicines in tropical Africa [19]. Such medicinal plants have played an important role as primary sources of traditional medicines in some communities in tropical Africa. Previous research by Kinghorn and Balandrin [20] and Van Wyk et al. [21] showed that 50% of pharmaceutical drugs and health products in clinical use today are derived from natural products isolated from plant species. Examples include aspirin derived from a compound called salicin isolated from Salix alba L. (family Salicaceae), artemisin from Artemisia annua L. (Asteraceae), colchicine isolated from Colchicum autumnale L. (Colchicaceae), opium obtained from Papaver somniferum L. (Papaveraceae), paclitaxel from Taxus brevifolia Nutt. (Taxaceae), quinine, an alkaloid obtained from Cinchona pubescens Vahl (Rubiaceae) and silymarin from Silybum marianum (L.) Gaertn. (Asteraceae) [21]. Therefore, it is within this context that this study aimed at reviewing the medicinal uses, phytochemistry and pharmacological properties of Astripomoea species was conducted.

2 MATERIALS AND METHODS

Several electronic databases were searched which included Web of Science, Elsevier, Pubmed, Google scholar, Springer, Science Direct, Scopus, Taylor and Francis. Additional information was obtained from pre-electronic sources such as books, book chapters, scientific journals and other grey literature obtained from the University library. The relevant terms included ethnobotany, medicinal uses, traditional uses, phytochemistry, pharmacology and toxicity of the extracts, and phytochemical compounds isolated from the genus Astripomoea. The Astripomoea species names were

authenticated using The Plant List managed by the Royal Botanic Gardens, Kew and the Missouri Botanical Garden (http://www.theplantlist.org/). Plant authorities were also authenticated through this process. The ultimate goal of this search was to explore articles that investigated the medicinal uses, phytochemical and pharmacological properties of Astripomoea. A total of 63 articles published between 1939 and 2021 matched the inclusion criteria and were included in this review (Fig. 1).

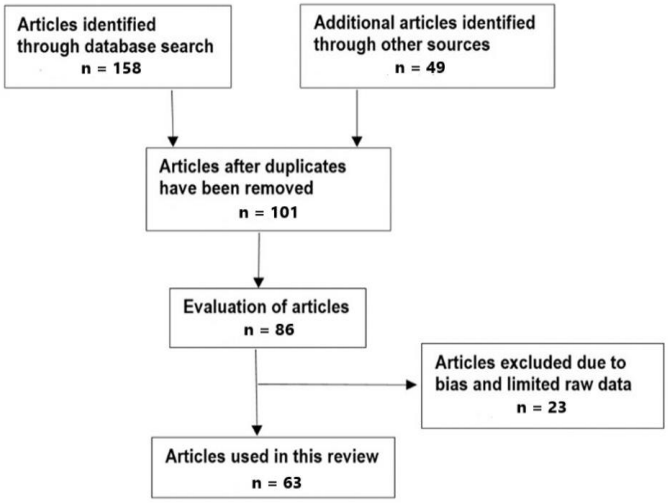

Fig. 1. *Flow chart showing the number of research publications used in this study*

3 RESULTS AND DISCUSSION

3.1 Taxonomy

The Plant List (http://www.theplantlist.org/) recorded 12 Astripomoea species, including A. cephalantha (Hallier f.) Verdc., A. delamereana (Rendle) Verdc., A. grantii (Rendle) Verdc., A. hyoscyamoides, A. lachnosperma (Choisy) A. Meeuse, A. longituba Verdc., A. malvacea, A. nogalensis (Chiov.) Verdc., A. polycephala (Hallier f.) Verdc., A. procera Thulin, A. rotundata (Pilg.) A. Meeuse and A. tubiflora (Hallier f.) Verdc. Species belonging to the Astripomoea genus are annual or perennial herbs bearing cymose inflorescences which are usually axillary sometimes forming a terminal panicle (Fig. 2). All these species with the exception of A. rotundata have been recorded in East Africa with centre of diversity of the genus in the East African region. About a third (33.3%) of the Astripomoea species are used as traditional medicines in tropical Africa and these include A. grantii, A. lachnosperma, A. malvacea and A. rotundata (Table 1). The synonyms of A. grantii include A. grantii (Rendle) Verdc., Astrochlaena grantii Rendle, A. ugandensis Rendle, Convolvulus malvaceus auct., sensu Oliv., non Breweria malvacea Klotzsch [18]. Astripomoea grantii has been recorded in Burundi, the Democratic Republic of Congo (DRC), Kenya, Rwanda, Tanzania and Uganda [22]. Astripomoea grantii is a s a perennial trailing herb, or shrub or short-lived perennial, erect or decumbent growing up to 1.2 m long with purple flowers with a whitish centre. The flowers of A. grantii are white and purple-pink at base with a whitish centre, inflorescence a subcapitate cyme and capsule ovoid [18]. Astripomoea grantii has been recorded in shallow moist soils around rocks and in grasslands [23].

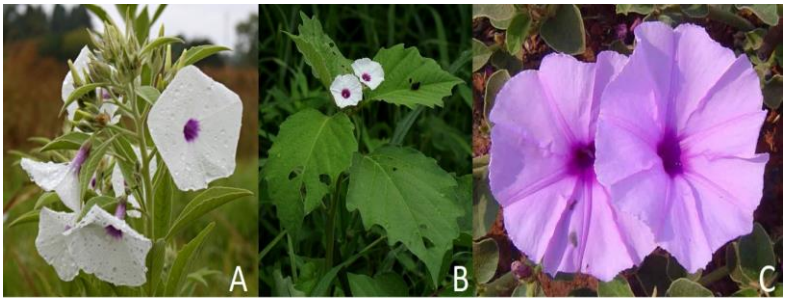

Fig. 2: *Images of* ***A:*** *Astripomoea hyoscyamoides,* ***B:*** *Astripomoea lachnosperma and* ***C:*** *Astripomoea malvacea (photos by Hyde M (A) and Wursten BT (B and C)*

Astripomoea hyoscyamoides (Vatke) Verdc. is an erect, shrubby, short-lived perennial or annual herb or soft, woody shrub growing up to 2.4 m long [24]. Astripomoea hyoscyamoides is a variable species with two recognized infraspecific taxa which are Astripomoea hyoscyamoides var. hyoscyamoides and Astripomoea hyoscyamoides var. melandrioides (Hallier f.) Verdc. The synonyms of A. hyoscyamoides include Astrochlaena hyoscyamoides (Vatke) Hallier f. ex Engl. and Convolvulus hyoscyamoides Vatke [25,26]. Astripomoea hyoscyamoides is characterized by several erect stem growing in great masses with alternate leaves, oval-shaped to elliptic ending abruptly in a distinct point with waxy margins that are covered with woolly hairs. The flowers of A. hyoscyamoides are funnel shaped, with white petals and purple tube. Astripomoea hyoscyamoides has been recorded in DRC, Kenya, Malawi, Somalia and Tanzania in shallow moist soils around rocks and in grasslands, desert grassland, bushland and disturbed areas at altitude ranging from 50 m to 1200 m above sea level [23,25,26]. The synonyms of A. lachnosperma include Astrochlaena lachnosperma (Choisy) Hallier f., Astrochlaena solanacea Hallier f., Convolvulus lachnospermus (Choisy) Hochst. and Ipomoea lachnosperma Choisy [15,27]. Astripomoea lachnosperma is an annual perennial herb growing up to 1.2 m long, with dense white hairs, white flowers with purple centre [22,28]. Astripomoea lachnosperma naturally occurs from eastern Nigeria and Cameroon, east to Somalia and south to Namibia, Botswana and South Africa, at an altitude ranging from 350 m to 2600 m above sea level [22,29]. Astripomoea lachnosperma is closely related to A. grantii but the flowers are smaller and the leaves usually less lobed [22]. Astripomoea malvacea naturally occurs from Saudi Arabia, west to Ghana east to Somalia and south to north-eastern South Africa [14,22]. The synonyms of A. malvacea include Astrochlaena engleriana Dammer, Astrochlaena floccose (Vatke) Hallier f., Astrochlaena ledermannii Pilger, Astrochlaena magisii De Wild., Astrochlaena malvacea (Klotzsch) Hallier. f., Astrochlaena menispermoides Standl., Astrochlaena mildbraedii Pilger, Astrochlaena phillipsiae (Baker) Rendle, Astrochlaena rotundata (Pilger) Meeuse, Astrochlaena stuhlmannii Hallier f. var. parviflora Rendle, Astrochlaena volkensii Dammer, Atrochlaena rotundata Pilger, Breweria malvacea Klotzsch, Convolvulus malvaceus (Klotzsch) Oliv., Convolvulus phillipsiae Baker and Ipomoea floccose Vatke [15,27]. Astripomoea malvacea is a variable species with accepted infraspecifics such as A. malvacea var. malvacea, A. malvacea var. epedunculata (Rendle) Verdc., A. malvacea var. involuta (Rendle) Verdc., A. malvacea var. floccosa (Vatke)

Verdc., A. malvacea var. parviflora (Rendle) Staples [15,28]. Astripomoea malvacea is an erect to climbing perennial herb or shrub growing up to two metres in height [22]. The stems are erect, woody, stout, cylindrical, hollow, rusty tomentose and brown in colour. The leaves are simple, alternate, condate with entire and waxy margins. The leaves of A. malvacea are elliptical to broadly ovate in shape, deeply cordate at the base and acuminate or rounded at the tip. The inflorescence is axillary with one to few-flowered racemes. The flowers are showy, bisexual, occurring in clusters, fused into a tube, pale mauve and dark purple at the entrance of the tube. The fruit is a globose capsule with ovoid seeds, that are trigonous, blackish-brown in colour with small turfs of hair around the hilum. Astripomoea malvacea has been recorded in woodland, fringing forest, grass savanna, bushland, roadsides, riversides, along swamps and occasional in neglected cultivations at an altitude ranging from sea level to 2250 m above sea level [14,29]. Astripomoea malvacea is browsed by cattle in Uganda [22,30] and the species has been described by Bowyer-Bower et al. [31] as a typical dominant of the clay soil-type areas, adapted to periodic fires which occasionally occur during the dry season. The synonym of A. rotundata is Astrochlaena rotundata Pilger [27]. Astripomoea rotundata is a trailing perennial herb growing up to 1.2 m long with large purple flowers [29]. Astripomoea rotundata naturally occurs in Botswana, Namibia and South Africa [22,29].

3.2 Medicinal uses of Astripomoea species

The aerial parts, flower sap, leaf sap, leaf smoke, leaf and root infusion or decoction of A. grantii, A. lachnosperma, A. malvacea and A. rotundata are mainly used to induce labour and as ethnoveterinary medicine, and traditional medicine for abdominal pains, constipation, cough, eye problems, inflammation, madness, malaria and swellings (Table 1; Figure 1). In most ethnobotanical studies, Astripomoea species are used alone, but often mixed with other species. For example, in Uganda, the pounded root extract of A. malvacea is mixed with the roots of Baccharoides adoensis (Sch.Bip. ex Walp.) H. Rob. and Momordica foetida Schumach. as traditional medicine for menstrual problems [32,33]. In the DRC and Rwanda, the leaves of A. grantii are mixed with those Hypericum revolutum Vahl, Pteris similis Kuhn & Decken, Lactuca attenuata Stebbins, Cryptolepis oblongifolia (Meisn.) Schltr. and Sonchus asper (L.) Hill, are mixed with clay to make a paste for massaging for mammitis and mastitis [18,22,34].

TABLE 1
MEDICINAL USES OF ASTRIPOMOEA SPECIES

Medicinal uses	Plant part	Country	Reference
Traditional medicines			
A. grantii			
Cold	Not specified	Kenya	35
Fever	Not specified	Kenya	35
Headache	Not specified	Kenya	35
Induce labour	Leaf decoction taken orally	Uganda	18,22,36,37
Malaria	Not specified	Kenya	35
A. lachnosperma			
Aphrodisiac	Not specified	Sudan	38
Blood purifier	Aerial parts decoction taken orally	Sudan	22
Colic	Not specified	Sudan	38
Cough	Not specified	Sudan	38,39
Fever	Not specified	Sudan	38
Flatulence	Not specified	Sudan	38
Malaria	Not specified	Sudan	38
Tonic	Not specified	Sudan	38
A. malvacea			
Abdominal pains	Leaf sap and root decoction taken orally	Tanzania and Zimbabwe	22,30,40
Abscesses	Leaf sap and root decoction applied topically	Tanzania	22,30
Anthelmintic	Leaf sap and roots taken orally	Tanzania	22,30
Blood circulation	Roots taken orally	Zimbabwe	40,41
Charm and ritual (good luck)	Roots	Kenya and Malawi	42,43
Constipation	Root infusion or decoction taken orally	Kenya and Uganda	40,44-47
Cough	Leaf sap taken orally	Malawi and Tanzania	22,30,40
Dysentery	Root decoction taken orally	Kenya	46,47
Ease delivery	Root decoction taken orally	Uganda	45
Epilepsy	Root decoction taken orally	Tanzania	48
Eye problems	Flower sap, leaf, leaf sap and root infusion applied topically	Malawi	22,30,40,43,49,50
Galactagogue	Root decoction taken orally	Uganda	45
Headache	Root powder rubbed into scarifications on the temple	Zimbabwe	22,40
Infertility in women	Root decoction taken orally	Zimbabwe	22,40
Inflammation	Flower sap, leaf, leaf sap and root infusion applied topically	Malawi	22,30,40,43,49,50
Madness	Smoke of leaves and roots inhaled	Zimbabwe	22,40,51-54
Malaria	Root decoction taken orally	Kenya	46,47,55
Menstrual problems	Pounded root extract of the plant mixed with the roots of Baccharoides adoensis (Sch.Bip. ex Walp.) H. Rob. and Momordica foetida Schumach.	Uganda	32,33
Stomach ache	Root decoction taken orally	Kenya	46,47
Swellings	Root infusion applied topically	Malawi	22,30,40,43,49,50
Vertigo	Root decoction taken orally	Zimbabwe	22,40
A. rotundata			
Eye problems	Root decoction applied topically	South Africa	22
Inflammation	Root decoction applied topically	South Africa	22
Swellings	Root decoction applied topically	South Africa	22
Ethnoveterinary medicine			
A. grantii			
Anaplasmosis	Leaf maceration	DRC	34
Anthrax	Crushed leaves applied as nasal and	DRC	18,34

	ear drops		
Gall disorder	Leaf and aerial part maceration used	DRC and Rwanda	22
Mammitis	Leaves mixed with those Hypericum revolutum Vahl, Pteris similis Kuhn & Decken, Lactuca attenuata Stebbins, Cryptolepis oblongifolia (Meisn.) Schltr. and Sonchus asper (L.) Hill, are mixed with clay to make a paste for massaging	DRC and Rwanda	18,22,34
Mastitis	Leaves mixed with those Hypericum revolutum Vahl, Pteris similis Kuhn & Decken, Lactuca attenuata Stebbins, Cryptolepis oblongifolia (Meisn.) Schltr. and Sonchus asper (L.) Hill, are mixed with clay to make a paste for massaging	DRC and Rwanda	18,22,34
Rabies	Leaf and aerial part maceration	DRC and Rwanda	18,22,34

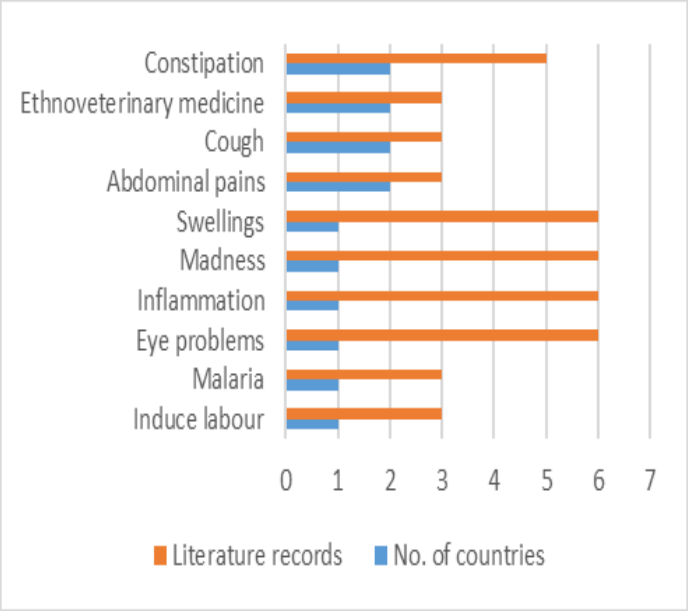

Fig. 3 *Medicinal uses of Astripomoea species*

3.3 Phytochemistry and pharmacological properties of Astripomoea species

Schimming et al. [56] identified 3-oxotropane (tropinone) from the aerial parts and root bark of A. malvacea, and this compound is considered a consecutive candidate as a precursor in the biosynthesis of the polyhydroxy alkaloid of the nortropane type (calystegines) [57,58]. Similarly, Otto et al. [59,60] isolated tropane alkaloids astrimalvine A N-oxide [3β-(3-tigloyloxy-2-methylbutyryloxy)tropane N-oxide], astrimalvine B [3β-(3-hydroxy-2-methylbutyryloxy)tropane], nor-astrimalvine A and a 3-tropanol ester from the root bark of A. malvacea. Kakengi and Genichi [61] and Kakengi and Idani [62] and evaluated the effect of vegetation type dominated by A. malvacea on the antibacterial activities of honey against Salmonella typhi ATCC 14023, Staphylococcus aureus ATCC 25923 and Escherichia coli ATCC 25922 using the agar wells diffusion method. Honey collected from vegetation type dominated by A. malvacea exhibited activities against the tested pathogens with inhibition zone ranging from 26.5 mm to 35.5 mm [61,62]. Similarly, Kakengi and Genichi [61] and Kakengi and Idani [62] evaluated the effect of vegetation type dominated by A. malvacea on the antifungal activities of honey against Candida albicans using the agar wells diffusion method. Honey collected from vegetation type dominated by A. malvacea exhibited activities against the tested pathogen with inhibition zone of 30.5 mm [61,62]. Whitby et al. [63] evaluated the antiviral activities of aqueous and organic extracts of A. grantii by assessing the in vitro Kaposi's sarcoma associated herpesvirus reactivation assay that measured increases in Kaposi's sarcoma associated herpesvirus viral load in Kaposi's sarcoma associated herpesvirus infected primary effusion lymphoma cells. The extracts caused Kaposi's sarcoma associated herpesvirus reactivation [63].

4 CONCLUSION

This review provides a summary of the current knowledge of the medicinal uses, phytochemistry and pharmacological activities of Astripomoea species. Several species are known to have medicinal uses and also used to induce labour and as ethnoveterinary medicine, and traditional medicine for abdominal pains, constipation, cough, eye problems, inflammation, madness, malaria and swellings. Extracts of Astripomoea were found to be rich in aliphatic tropine, nor-tropine esters and the alkaloid astrimalvine A N-oxide. Many biological activities have been investigated, in particular antibacterial, antifungal and antiviral activities. Most of the studies focused on crude extracts, and only a few on phytochemical compounds isolated from the Astripomoea species. Although several studies have been conducted into the phytochemistry and pharmacological properties of A. grantii and A. malvacea, there are still gaps on the correlation of medicinal application of the Astripomoea species, their ethnopharmacological properties and toxicity. Therefore, detailed studies focusing on the phytochemical, pharmacological and toxicological properties of Astripomoea species are recommended. This review provides a summary of the current knowledge of the medicinal uses, phytochemistry and pharmacological activities of Astripomoea species. The literature indicates that the Astripomoea species are widely used in southern Africa as charm and ritual purposes, and traditional medicines for snake bites, venereal diseases, rheumatism, gastro-intestinal problems, headache, fever and respiratory infections. The phytochemistry studies have shown diverse phytochemical constituents. Therefore, detailed studies focusing on the phytochemical, pharmacological and toxicological properties of Astripomoea species are recommended. Therefore, clinical studies are required to assert the traditional uses of the remaining species. More research using in vivo models is needed to evaluate potential toxicity and clarify the specific mechanisms of action to the plant extracts and isolated compounds from these species. Toxicology data for this genus is scant. Existing studies, while limited, exist suggest that Astripomoea species are deserving of further investigation, and that studied should include those not previously documented as having traditional use. Few

pharmacological studies based on traditional uses of the plants of the genus Astripomoea were done in animal models. Furthermore, few toxicological evaluations of the extracts have been reported in vivo. This review links the pharmacological activities to traditional uses and phytochemistry, and provides insight into the medicinal potential of the genus Astripomoea. Pharmacological studies have provided supporting evidence for therapeutic potential of this genus. However, the research designs of pharmacological studies based on traditional uses are strongly needed in cell lines and animal models. Further in vitro and in vivo animal studies are required for toxicological evaluations, identifying active ingredients, and the mechanisms mediating bioactivities before future clinical researches.

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