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Phyllanthus fluitans (Phyllanthaceae): a new record of an aquatic plant for the flora of Panama

Phyllanthus fluitans (Phyllanthaceae): un nuevo registro de planta acuática para la flora de Panamá

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Abstract:

Background and Aims: *Phyllanthus fluitans* is the only aquatic free-floating species in the family Phyllanthaceae. It occurs in South American wetlands and has also been reported in Mexico, where it is considered non-native. It is used as an aquarium plant and has escaped cultivation in Florida (USA). The objective of this study is to report the presence of this species in Panama, collected in the Matusagaratí complex of wetlands, in the Darién Province.

Methods: This work is based on floristic field surveys in Matusagaratí, during both the dry and wet seasons, study of specimens and consultation of relevant literature. A general distribution map of the species is drawn based on GBIF data and its conservation status in Panama is assessed according to IUCN criteria.

Key results: This is the first record of the aquatic plant *Phyllanthus fluitans* in Panama. The distribution of the species is discussed in the light of this new finding. Data on the ecology of the species in Panama are presented.

Conclusions: The presence of *Phyllanthus fluitans* is confirmed in Panama, representing an extension of the natural range of the species. Only one population has been found in an herbaceous seasonally flooded habitat that is periodically burned. In our national conservation analysis, we recommend the species to be considered as Endangered (EN), and this population to become a conservation target. This study reaffirms the importance of carrying out explorations in botanically poorly known regions, such as the Darién.

Key words: complex of wetlands, Darién, Matusagaratí.

Resumen:

Antecedentes y Objetivos: *Phyllanthus fluitans* es la única especie acuática de libre flotación en la familia Phyllanthaceae. Aparece en humedales de América del Sur, pero ha sido también citada de México, donde se considera no nativa. Se utiliza como planta de acuario y se ha escapado de cultivo en Florida (EUA). El objetivo de este estudio es informar sobre la presencia de esta especie en Panamá, colectada en el complejo de humedales de Matusagaratí, en la provincia de Darién.

Métodos: Este trabajo se basa en inventarios florísticos realizados en Matusagaratí, tanto durante la estación seca como en la húmeda, en el estudio de especímenes y en la consulta de literatura relevante. Se hizo un mapa de la distribución general de la especie utilizando los datos de GBIF y se evaluó su estado de conservación en Panamá de acuerdo con los criterios de la UICN.

Resultados clave: Este es el primer registro de la planta acuática *Phyllanthus fluitans* en Panamá. Se discute la distribución de la especie a la luz de este nuevo descubrimiento. Se presentan datos sobre la ecología de la especie en Panamá.

Conclusiones: Se confirma la presencia de *Phyllanthus fluitans* en Panamá, lo que representa una extensión del límite de distribución natural de la especie. Solo se encontró una población en un herbazal estacionalmente inundado, el cual es quemado de manera periódica. Tras el análisis de conservación a nivel nacional, se recomienda considerar la especie como En Peligro (EN) y que esta población se convierta en un objeto de conservación. Este estudio reafirma la importancia de llevar a cabo exploraciones botánicas en regiones poco estudiadas, como lo es la de Darién.

Palabras clave: complejo de humedales, Darién, Matusagaratí.

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Introduction

Phyllanthus L. is the largest genus in the family Phyllanthaceae with ca. 880 species in the tropics worldwide (sensu Bouman et al., 2018), and ca. 220 in the Neotropics (Webster, 2002). It shows a variety of habits, from herbs to shrubs and trees, and occurs in a wide range of ecosystems, from open habitats to the understory and canopy of wet tropical forests. Fourteen species of *Phyllanthus* have been reported in Panama, 10 native including one endemic to the country (the tree *Phyllanthus gentryi* G.L. Webster, Darién Province) and four introduced weeds or cultivated trees (Correa et al., 2004).

Three *Phyllanthus* species have been reported to be aquatic. Two African herbs, *Phyllanthus felicis* J.F. Brunel and *Phyllanthus leonardianus* Lisowski, Malaisse & Symoens are rooted emergent plants, while the neotropical *Phyllanthus fluitans* Benth. ex Müll. Arg. is a free-floating species, the only one within the entire family (Lisowski et al., 1974; Brunel, 1987).

Phyllanthus fluitans is included in the subgenus *Phyllanthus* within the monotypic section *Salviniopsis* Holm-Nielsen ex Jean F. Brunel, thus containing this species only (Brunel, 1987; Falcón Hidalgo et al., 2020). It is a small floating species similar in habit and leaf shape to the water fern *Salvinia* Ség. and is usually described as *Salvinia*-like. It has a highly specialized morphology with leaves modified as floating organs, in the form of aerial sacs (Lot et al., 1980).

Phyllanthus fluitans was discovered and first collected by Richard Spruce in the lower Amazon of Brazil in 1850. The specimen was sent to George Bentham and its original description published in 1863 by Jean Müller (Müller Argovienensis, 1863; Lot et al., 1980). It has since been reported in Paraguay (Chodat, 1906), Colombia (Schultes, 1949), Peru (Macbride, 1951; Gómez, 2006), Argentina (Lourteig, 1955; Donnet and Yedro, 1996), Ecuador (Holm-Nielsen, 1980), Venezuela (Díaz and Rosales, 2006), Bolivia (Jørgensen et al., 2014) and Mexico, where it was doubted whether it is native (Lot et al., 1980; Webster, 2002), and recently Espinosa-García and Villaseñor (2017) considered it a non-native species.

Due to its attractive leaf shape and coloration, the species is widely used in aquariums worldwide. In Florida

it has escaped cultivation and now poses a serious threat to natural ecosystems as an invasive species (Wilder and Sowinski, 2010; PPQ, 2017).

The objective of this study is to report the presence of *Phyllanthus fluitans* in Panama, more specifically in the Matusagaratí complex of wetlands, in the Darién Province.

Materials and Methods

The Tuira and Balsas rivers in Darién, Panama, are the backbone of the Matusagaratí complex of wetlands, one of the largest wetlands in Central America, covering around 50,000 ha (Carol et al., submitted). It includes river margins and adjacent floodplains, which contain different vegetation types such as swamp forests, scrublands and herbaceous formations. All these communities are periodically flooded, and their structure and species composition are defined by their landscape position and the nature and duration of the inundation, which can be from estuarine waters related to daily tides, spring tides, fluvial and/or rainfall flooding (Grauel, 2004; CREHO, 2015; MiAmbiente, 2016; Carol et al., submitted). Away from the main rivers' influence, extensive areas are covered in herbaceous formations dominated by *Typha dominguensis* Pers. and other wetland species (Ibáñez et al., in prep.). Precipitation in the region has been reported to be around 2500 mm/year, with a pronounced dry season from January to April, and a wet season from May to December. Mean temperature varies from 21.6 °C to 24 °C (Grauel, 2004; MiAmbiente, 2016). Wetland soils in the study area are gleyed, acidic (4.5-5 pH), and saturated, with the water table just below the surface in anoxic conditions (Ibáñez et al., in prep.).

As part of a research project that aims at describing the hydrology, vegetation and avifauna of the complex of wetlands of Matusagaratí, a floristic survey was carried out. General collecting of aquatic flora in selected sites was done during four trips (a total of 21 days in the field) encompassing both the dry and wet seasons. All specimens were preserved in newspaper with 50% ethanol while in the field and dried in the herbarium afterwards. Botanical specimens collected were studied at the University of Panama herbarium (PMA), where voucher specimens of all collections have been deposited. The results

of the general floristic survey will be published in a forthcoming paper (Ibáñez et al., in prep.).

Phyllanthus fluitans is the only aquatic free-floating species in the genus *Phyllanthus* and has unique morphological characters that make it unmistakable, such as the aerial sacs of the leaves. The specimen collected, A. Ibáñez and N. Gálvez 9672 AI, was studied in detail and compared with the images of type specimens in the JSTOR Global Plants database (JSTOR, 2020) and with available online resources, such as the numerous images of the species (e.g. UF/IFAS, 2020). Our specimen fits published descriptions of the species such as those of Lot et al. (1980) and Holm-Nielsen (1980). In order to complement the distribution data of *P. fluitans*, we consulted the GBIF database (GBIF, 2020) and used that information to draw the map in Fig. 1A. Maps were made with ArcMap version 10.5 (ESRI, 2016). The IUCN Red List Categories and Criteria (IUCN, 2001) and GeoCAT (Bachman et al., 2011) are used to determine the conservation status of this species in Panama.

Results

Phyllanthus fluitans Benth. ex Müll. Arg., Linnaea 32(1): 36. 1863. Figs. 2A-B.

TYPE: BRAZIL. Pará, Brasilia, prope Santarem ad Rio Negro in aquis fluitans cum Azollis, R. Spruce s.n. (lectotype not designated, putative syntypes: A!, BM!, G!, G-DC!, GH!, K!, MPU!, NY!, P!, RB!, TCD!).

Macrophyte herb with horizontal stems, 3-5 cm long; branching non-phyllanthoid; rootlets many; stipules acuminate, 2 mm long; leaves sessile or with up to 1 mm long petiole, distichous, blades orbicular, cordate at base, 12-20 mm broad, glandular, with the two sides inflated and forming 2 aerial sacs, margin entire, revolute in immature leaves, leaves green, sometimes red; plant monoecious; inflorescences axillary cymules, flowers 2-4, unisexual, apetalous, petaloid sepal lobes 6, white or light pink; male flowers, disc with 6 segments, stamens 3, filaments free, anthers horizontally dehiscent; female flowers, disc with 6 lobules, superior ovary with 3 locules, 2 ovules each, styles 3, bifid, stigmas dark, papillose; fruits capsular depressed-globular,

3 mm wide, seeds triangular, 6 per capsule, dispersed by water. For a detailed morphological and anatomical description see Holm-Nielsen (1980) and Lot et al. (1980).

Material examined: PANAMA. Provincia de Darién, Humedal Laguna de Matusagaratí, El Golfo, 18 m s.n.m., 8°17'20.45"N, 77°54'50.88"W, 6.X.2019, fl., A. Ibáñez and N. Gálvez 9672 AI (PMA).

Habitat and ecology: *Phyllanthus fluitans* was found in a seasonal pool in the NW corner of the herbaceous wetland (Fig. 1B). It was growing abundantly during the rainy season in October and November 2019 (Figs. 2A-C). The pool was ca. 80 cm deep and accompanying free floating and rooted macrophyte species were *Pistia stratiotes* L., *Ceratopteris thalictroides* (L.) Brongn., *Spirodela polyrhiza* (L.) Schleid., *Azolla filiculoides* Lam., *Eleocharis* spp., *Thalia geniculata* L., *Typha dominguensis*, *Crinum erubescens* Aiton, *Nymphoides indica* (L.) Kuntze, *Nymphaea* sp., *Ludwigia nervosa* (Poir.) H. Hara, *Ludwigia* spp. and *Aeschynomene* cf. *indica* L. This part of the herbaceous wetland had no standing water during the dry season of 2019, although the soil was damp enough for some of the floating species to remain alive. The whole region burned at the end of the same season, in early May 2019. This area is bordered by cattle pastures and the animals are free to enter during the dry months, where they usually rest and refresh.

Conservation status: only one population of *P. fluitans* was found in the Matusagaratí wetland. This region is included in the Filo del Tallo-Canglón Forest Reserve, a protected area within the National System of Protected Areas of Panama (MiAmbiente, 2016). Despite its protected status, the herbaceous vegetation is frequently burned and used by cattle ranchers, practices that are causing a highly negative impact on the flora and fauna of the wetland. Moreover, large tracts have been recently drained and transformed to intensive rice and oil palm plantations (CREHO, 2015). According to our national conservation analysis, *P. fluitans* should be considered as Endangered (EN B2ab (ii, iii, iv)) in Panama, because of its restricted Area of Occupancy (4 km²) and the threats the whole region faces, especially the uncontrolled burning of pastures and adjacent herbaceous wetlands.

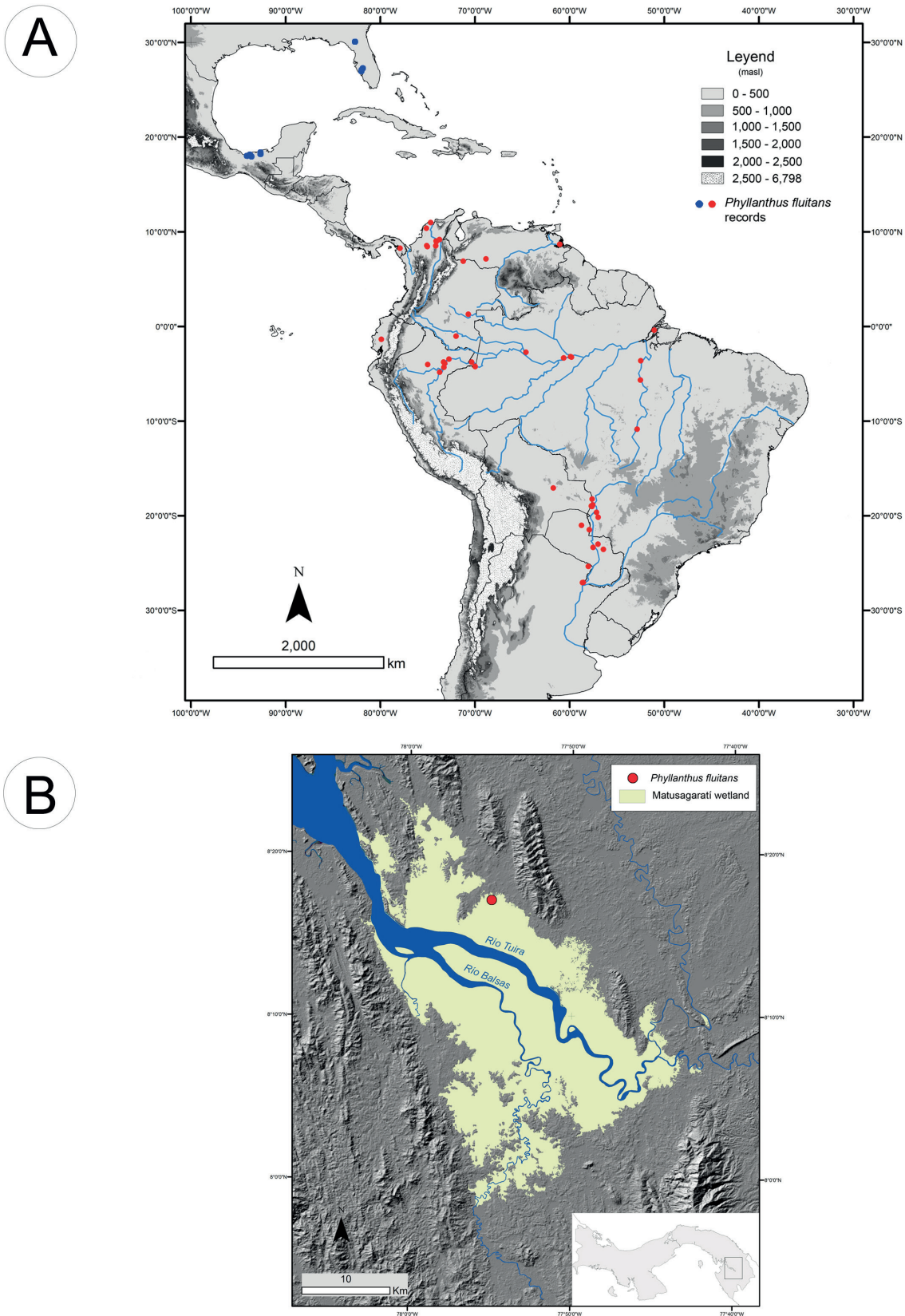


Figure 1: A. distribution of *Phyllanthus fluitans* Benth. ex Müll. Arg. Occurrence data from GBIF (2020); in red native, in blue non-native records; B. location in Matusagarati complex of wetlands in Darién Province, Panama.

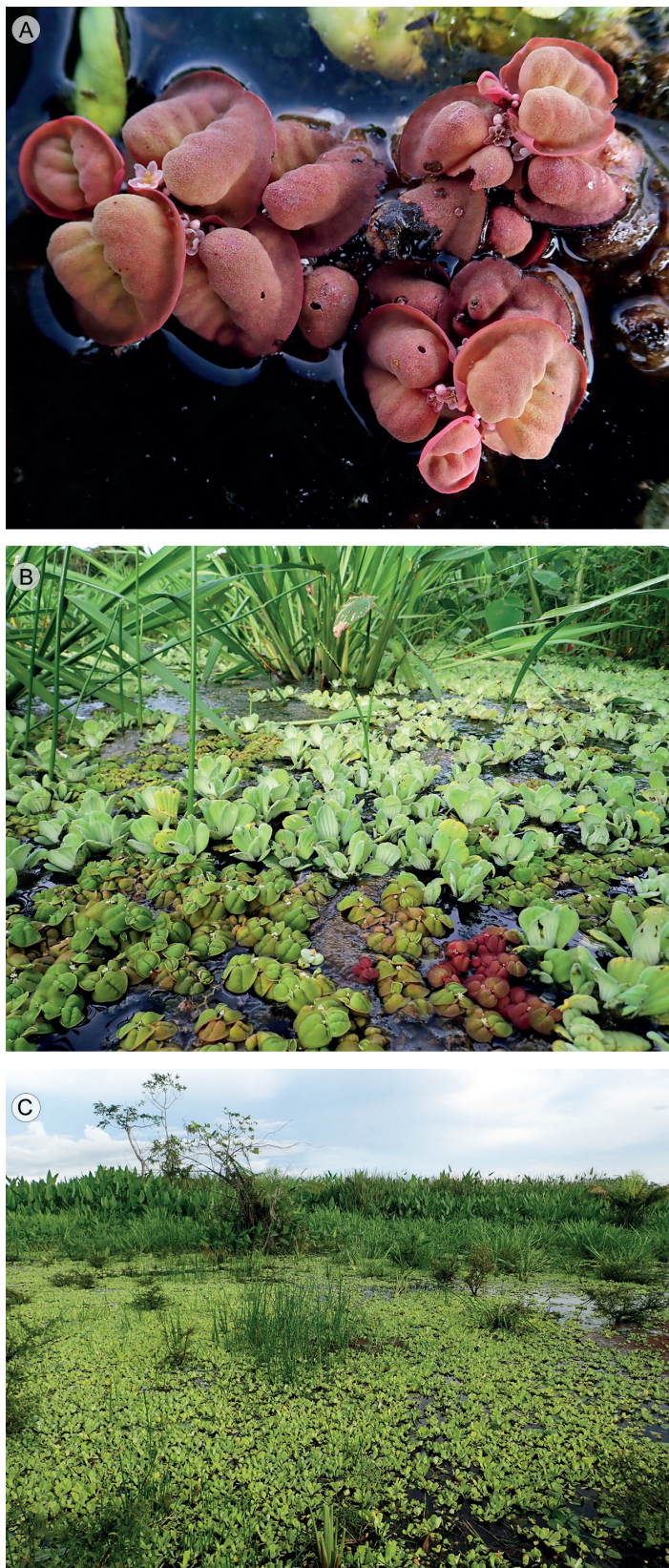


Figure 2: A. flowering *Phyllanthus fluitans* Benth. ex Müll. Arg.; B. green and red plants of *P. fluitans* growing with *Pistia stratiotes* L.; C. seasonal pool with wetland vegetation where *P. fluitans* was found. Photos by Alicia Ibáñez.

Discussion

Phyllanthus fluitans is a South American species that grows mostly along the Amazon river and tributaries but it has also been reported in the Magdalena, Orinoco and Paraná watersheds (GBIF, 2020). It is notable that the Ecuadorean record is west of the Andes (Holm-Nielsen, 1980) (Fig. 1A).

In Mexico, the species occurs in the Tabasco wetlands, in permanent pools of temporarily flooded cattle pastures (Lot et al., 1980). This disjunct distribution pattern has been the subject of some discussion. Despite the similarity of wetland habitats with South America and the many shared widespread species, the absence of *P. fluitans* in Central America and its occurrence in a secondary habitat such as flooded cattle pastures suggest that it is a recently introduced species (Lot et al., 1980; Webster, 2002; Espinosa-García and Villaseñor, 2017), and might be explained by long distance dispersal by migratory birds (Green et al., 2002; Mora-Olivo et al., 2013).

Although the presence of *P. fluitans* in Panama could also be explained as a recent introduction by migrant waterfowl, it is likely an extension of its native South American range. The herbaceous flora of these wetlands had never been surveyed before, and as in the case of other wetland species (e.g. *Montrichardia linifera* (Arruda) Schott, Ortiz et al., 2020), this region has a strong affinity to South America.

In Panama, the species is not for sale in aquariums (MiAmbiente, 2020), so the possibility of it escaping cultivation is not considered here. This is also supported by the fact that the area where it was found is remote, with difficult access by dirt roads, very far from putative sources of this kind of invasive species (aquarium plants).

The habitat and ecological characteristics of the *P. fluitans* population from Darién are consistent with documented specimens from South America and Mexico (Lot et al., 1980; Schmidt-Mumm and Janauer, 2014). The distribution of aquatic plants fluctuates throughout the year. With rising water level, the floating vegetation develops and expands until it reaches its full extension during the high-water period (Junk, 1970). *Phyllanthus fluitans* has only been observed during the high-water period of the rainy season in October-November 2019, growing amid exuberant floating vegetation. In Mexico it has been reported to behave as an annual or perennial herb according to the environ-

mental conditions and duration of the inundation (Lot et al., 1980), and the species has also been reported as being able to root and grow in damp soil (Sowinski, 2011). In the Matusagaratí wetland, the species seems to be able to survive the strong dry season of 4-5 months, either as seeds or rooted in the damp soil.

This new record of *P. fluitans* in Darién, Panama, represents an extension of the known natural range of the species. More intense fieldwork is needed to evaluate the range and ecology of this species in Darién and Panama and formulate more robust hypotheses to explain its presence in the region. The only population found is highly vulnerable and it should be considered a conservation target. This study reaffirms the importance of continuing with botanical explorations in botanically poorly known regions, such as the Darién.

Author contributions

AI designed the research. AI and RF performed research, analyzed the data and wrote the manuscript.

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