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Ecology, propagation and traditional medicinal uses of woody plant species within the Apocynaceae

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Abstract

Forest cover is being lost quickly in Ghana due to illegal mining, shifting cultivation and construction activities despite the ecosystem services, food, medicine and timber that forests provide. This review examined the ecology, propagation and traditional medicinal uses of woody plant species within the Apocynaceae based on information and data from textbooks and databases. Sixty-nine plant species were identified, of which 46 (approxi-mately 67 %) were of medicinal importance. There were ambiguities in describing their life form. The predominant life form (approximately 33 %) was liana. There was scanty information on the species' phenology, propagation and conservation status. Ethnomedicinal uses of plants play a pivotal role in traditional medicine systems across the globe. These practices usually involve using plants and plant -derived substances to treat different health conditions. The ethnomedicinal uses covered acute, chronic, reproductive health conditions and brain disorders. Significant gaps exist in the ecology and conservation status of the species of this family, especially concerning lianas. Investigating the species' growth conditions, phenology, propagation and productivity is crucial to aid in their conservation efforts. By understanding these factors correctly, researchers will develop strategies to protect and promote the species' health and population. This will play a significant role in creating conservation plans, managing habitats and ensuring the sustainability of the species.

Keywords

acute; apocynaceae; chronic; ethnomedicinal; phenology

Introduction

The Apocynaceae is a family of plants with widespread distribution, but the plant species are chiefly found in tropical and subtropical regions worldwide. The Apocynaceae comprises large and small trees, shrubs, lianas and a few herbs, usually with latex (1). About 2000 species have been identified under approximately 200 genera, although different authors quote different estimates. The leaves are simple, opposite, decussate, rarely alternate, whorled and usually exstipulate.

The flowers are often showy with cymose inflorescence, bisexual, actinomorphic, hypogynous, funnel-shaped or salver-shaped (slender, tubular corolla which lobes spread at right angles to the tube) and often with a corona. The calyx is gamosepalous with five sepals, rarely four, united at the base. The corolla is gamopetalous with five, rarely four, twisted or contorted petals as the aestivation. The androecium is epipetalous with five, rarely four stamens alternating with the petals and having connate anthers around the stigma, to which they are usually adnate. The gynoecium consists of two apocarpous or

syncarpous pistils with a superior ovary. When apocarpous, each ovary is one-celled with marginal placentation and when syncarpous, the ovary may be one-celled with parietal placentation or two-celled with axile placentation. There are two to indefinite ovules in each ovary (2). The fruit may be a drupe, a berry, a capsule, or a follicle. The seeds are often winged or have a tuft of long silky hairs at the base or both ends.

Taxonomically, members of the family are classified into the following taxa: Kingdom: Plantae; Subkingdom: Tracheobionta; Division: Magnoliophyta; Subdivision: Spermatophyta; Class: Magnoliopsida; Subclass: Asteridae; Order: Gentianales; Family: Apocynaceae; Genus; and Species.

Practically, all family members are poisonous and many species are used in conventional medicine because of cardiac glycosides and various alkaloids. Members of the family Apocynaceae are rich in alkaloids, flavonoids, glycosides and hydrocarbons. Lactones, simple phenols, steroids and terpenoids (3).

In traditional medicine, many species of the Apocynaceae are used to treat aches and pains, asthma, diabetes, epilepsy, fever, gastrointestinal conditions, heart conditions, hypertension, malaria, menstrual problems, mumps, reproductive health issues in both males and females, skin conditions, tumours, venereal diseases (4-6) and a host of other conditions.

Despite the importance of this family, there is a dearth of information on the phenology and conservation status of members of the plant family Apocynaceae. Meanwhile, threats to biodiversity are palpable and increasing daily due to anthropogenic activities exemplified by mining, construction works and shifting cultivation due to unplanned land use resulting in habitat loss and fragmentation. Another area where humans seriously threaten biodiversity is the over-exploitation of species. Almost every radio station in Ghana spends a lot of time advertising plant medicine. Private and public bus passengers are disturbed daily by people selling plant medicine, even in moving coaches. Minivans and saloon cars move about canvassing the purchase of medicinal plant products from door to door and at lorry stations and marketplaces over megaphones, microphones and recorded messages at deafening sound levels. The extent to which the species are being exploited is not known. However, one may say that tonnes of plant materials are removed from the natural (forest) vegetation because this practice is nationwide. Climate change also poses significant threats to many ecological systems (7). Therefore, proactive steps have to be taken to avert or minimize all human activities that are inimical to the existence and survival of biodiversity, predominantly plants, taking cognizance of the averred Ghanaian statement, "When the last tree dies, the last man dies".

Information on plant ecology, propagation and medicinal uses is necessary to manage and conserve the affected plant species. The main objective of this review is to synthesize information on the ecology, propagation and ethno-medicinal uses of woody plant species of the family Apocynaceae. The article reviewed literature on the life form, habitat, distribution, phenophase, propagation, conservation status and medicinal uses of the Apocynaceae woody plant species. The information gathered is expected to be helpful to researchers and students of pharmacology, pharmacognosy and phytochemistry and conservation biologists.

Materials and Methods

The information and data on the woody species of the Apocynaceae were collated from textbooks-Woody Plants of Ghana (8), FROGGIE, Forest Reserves of Ghana: Geographical Information Exhibitor (9), Woody Plants of Western African Forests: A guide to the forest trees, shrubs and lianes from Senegal to Ghana and databases-Useful Tropical Plants Database 2014, PROTA and Tropicos.org (10-12). Missouri Botanical Garden, Royal Botanic Gardens, Kew- Plants of the World Online, ResearchGate, PubMed, ScienceDirect, JASTOR Global Plants, Google and Google Scholar. As a habit, Liana was defined as a woody climber, irrespective of climbing shrubs and no distinction was made between small or large trees (13). It is used as the primary checklist of the species. The species' conservation status and conservation star rating were sought based on the IUCN 2021 Red List and Star rating (8, 9). The star rating is a colour scheme whereby species are assigned coloured stars. Green star species are of no conservation consideration, Pink star species are of some commercial interest, Red star is for highly exploited species in Ghana, Scarlet species are threatened in Ghana by over-exploitation, Blue star species are of rarity concern in Ghana, Gold star is globally restricted and Black star species are rare globally and are high priorities for careful management (14, 15).

Results

The results presented a checklist of species, life forms, guild, habitat, distribution, phenophase, propagation, IUCN conservation status, star rating and medicinal uses. Of the 69 fully identified species belonging to the Apocynaceae described (8). 46 (approximately 67 %) are of medicinal importance. There are ambiguities in describing the life form. While some species were described as shrubs or trees, others were described as shrubs or liana. The predominant life form is liana (n =23, approximately 33 %). The literature has scanty information on the phenology of the woody plant species reviewed. The phenological data available is insufficient. Only one source attempted to provide information on phenology (8). Where this was done, no mention was made of the duration of the phenophases, namely leaf budding, leaf flushing, leaf shedding, floral bud appearance, anthesis, flower drop, fruit set and ripening.

Notwithstanding, flowering data was provided more than fruiting data (8). There is no information on flushing. This is understandable, given that there are no significant seasonal variations in Tropical West Africa, leaving the species predominantly evergreen or semi-deciduous. There is no consistency in the naming of the habitat type. The distribution of the species was broadly given by (8) Jastor: Global Plants, Useful Tropical Plants Database and PROTA.

Meanwhile, the countries where the species can be found were provided by the Royal Botanic Gardens, Kew

(Plants of the World Online) database. Information on propagation was essentially provided by the Tropical Plants Database and, on rare occasions, by Irvine. According to the IUCN Red List and Star rating, the conservation status has not been provided by the reference literature for this review (9). A subsequent check from the IUCN (The IUCN Red List of Threatened Species. Version 2021-2. https://www.iucnredlist.org) yielded no information on the conservation status of the species except for a few species, as indicated in Supplementary Table 1.

Discussion

Ecology and propagation

The dearth of information on the conservation status of the woody plant species within the Apocynaceae may be attributed to the limited attention they receive. Many of the species identified in this review are lianas, often regarded as a nuisance due to their tendency to reduce the productivity of host plants. Lianas cause premature leaf shedding, intercept sunlight and compete with desirable timber species for moisture and nutrients, potentially suppressing growth or even death of host trees (16). Farmers frequently clear lianas to plant desired crops and at best, they are utilized for practical purposes such as ropes or twines.

Despite these challenges, lianas play vital roles in the forest ecosystem, contributing to biodiversity, carbon sequestration and providing food for animals (17-18). They also facilitate the movement of arboreal species by linking up tree crowns (19), which may help prevent tree falls by maintaining structural integrity in the canopy. Conversely, tree fall may only occur when the canopy is significantly disrupted. This ecological complexity calls for further investigation into the role of lianas and the other species within the Apocynaceae family.

The fundamental challenge in assessing and assigning IUCN global conservation status to these plants is that many countries have their assessment schemes (20). The star rating of plant species provided by FROGGIE reflects this variability. Moreover, the IUCN Red List tends to be biased towards animals and when the focus is on plants, it often favours trees over other life forms, further complicating conservation efforts.

While the discussion does not extensively cover propagation methods, understanding the ecological roles and interactions of lianas and other woody plant species is essential for developing effective propagation and conservation strategies.

Traditional Medicinal Uses

The high number of species of medicinal importance in the Apocynaceae was confirmed in research, indicating that 19 out of 25 in 16 genera of the Apocynaceae were identified in Kenya as ethnobotanical or ethnomedicinal value (21). Also, the current review confirms the categories of diseases treated with medicinal plants of the Apocynaceae (4-6).

The ethnomedicinal use of Apocynaceae species for treating various ailments is supported by their alkaloid content, which has been shown to exhibit a range of biological activities (22), including analgesic, antiarrhythmic, antiasthmatic, antibacterial, anticancer, antihyperglycemic, antimalarial, cholinomimetic, psychotropic, stimulant and vasodilatory effects (23). The Apocynaceae is renowned for its antibacterial and anticancer effects and its usage in treating jaundice, diabetes and hypertension (24). In traditional medicine, Apocynaceae species treat fever, malaria, pain, diabetes and gastrointestinal ailments, including skin and ectoparasitic diseases (25). Some species have also demonstrated effects on the cardiovascular system attributable to their glycoside content. For instance, glycosides such as digitoxin, digoxin and convallotoxin enhance heart strength and contraction rates while exhibiting diuretic effects by stimulating urine production and facilitating fluid removal from tissues and the circulatory system (26).

In addition to alkaloids, other significant phytochemicals present in Apocynaceae include flavonoids, hydrocarbons, lactones, simple phenols, steroids and terpenoids. These compounds share various biological activities; for example, flavonoids are recognized for their anticancer, anti-inflammatory, antioxidant and neuroprotective properties, while terpenoids exhibit similar effects and potential memory-enhancing capabilities. The biological properties of these phytochemicals align with the medicinal uses of the species documented in the review, underscoring their significance in traditional medicine.

Conclusion

This study emphasizes the importance of identifying and addressing the threats to forest ecosystems in Ghana. It highlights the importance of understanding plant species' ecology, propagation and conservation status within the Apocynaceae to warrant long-term survival and harness their potential in ethnomedicine. The family Apocynaceae contains beneficial species of ethnomedicinal and conventional medicinal importance to attract the attention of researchers and students of pharmacology, pharmacognosy and phytochemistry, conservation biologists and industry players. Nonetheless, significant gaps exist in the ecology, propagation and conservation status of the species of this family, especially concerning lianas. Given the importance of the species identified in this review and the spate of destruction of Ghana's forest cover about illegal mining in forest reserves and other land use types, namely shifting cultivation and construction activities, efforts should be made to conserve the plant species. Information on the growth conditions, phenology, propagation and productivity of the species should be collected to serve conservation, research and education purposes.

Authors' contributions

EA and AP authors participated in all parts of the current study.

Compliance with ethical standards

Conflict of interest: No competing interest is present in the current study.

Ethical issues: None

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