



A new species of *Impatiens* (Balsaminaceae) and rediscovery of *Impatiens aliciae* from the Western Ghats of India

Bince MANI^{1,*}, Sinjumol THOMAS², Susai John BRITTO³

1. Department of Botany, St. Thomas College Palai, Kottayam–686574, India.

2. Department of Botany, Carmel College, Mala, Thrissur–680732, India.

3. The Rapinat Herbarium and Centre for Molecular Systematics, St. Joseph's College (Autonomous), Tiruchirappalli - 620002, India.

*Corresponding author's email: binsnm@gmail.com

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ABSTRACT: A new *Impatiens* species, *I. periyarensis* is described from the Western Ghats, India. It is found on the open dripping rocks in semi-evergreen forests in Idukki. Additionally, an enigmatic taxon *I. aliciae*, from Valara, Idukki, is rediscovered after its type collections in 1933 by Barnes. A detailed description, illustration, phenology, and notes on both the species are provided.

KEY WORDS: Balsams, *Impatiens josephia*, Kerala, Travancore.

INTRODUCTION

Impatiens Linnaeus, consists of more than 1000 species, chiefly distributed in the montane forests of the tropics and subtropics of the Old World with five centres of diversity namely tropical Africa, Madagascar, South India and Sri Lanka, Sino-Himalaya and South east Asia (Grey-Wilson, 1980; Mabberley, 2017). In India, the number of species of *Impatiens* is estimated to be more than 210 and its distribution is remarkably local and occurs in two well-defined regions viz., the eastern Himalaya in north and the Western Ghats in south (Bhaskar, 2012). Among these, approximately 120 species of *Impatiens* are endemic to the Western Ghats, of which more than 80% are endangered (Bhaskar, 2012, Bhaskar and Sringswara, 2017; Mani and Thomas, 2017; Mani *et al.*, 2018, Salish *et al.*, 2019, Subbiah and Vellingiri, 2019; Vishnu *et al.*, 2020). During the botanical explorations in the Western Ghats the authors came across two interesting specimens of *Impatiens* from Alady and Valara in Idukki district, Kerala. A detailed analysis of the specimens followed by consultation of relevant literature (Fischer, 1934, Bhaskar, 2012, Bhaskar and Sringswara, 2017, Mani and Thomas, 2017, Ramasubbu *et al.*, 2017, Mani *et al.*, 2018) revealed that the specimens collected from Alady do not match with any hitherto described species and the latter specimen perfectly match with *Impatiens aliciae* C.E.C. Fisch. Therefore, the former specimen is treated as a new species namely *I. periyarensis* while *I. aliciae*, an interesting taxon which created taxonomic ambiguity, and now has been collected after a lapse of 87 years after its type collections by Barnes in the year 1934. This is treated as a rediscovery below.

TAXONOMIC TREATMENT

Impatiens periyarensis B. Mani, Sinj. Thomas & Britto, *sp. nov.* **Fig. 1**

Type: INDIA. Kerala, Idukki district, Alady, 900 m a.s.l., 28 August 2016, *Bince Mani 68670* (holotype RHT!, isotypes MH!, RHT!, Acc. 076720)

Diagnosis: *Impatiens periyarensis* is similar to *I. josephia* Sinj. Thomas, B. Mani & Britto but differs by its spatulate and toothed extrafloral nectaries (vs. non-spatulate and non-toothed), lanceolate leaves (vs. linear), glabrous lateral sepals (vs. pubescent), funnel-shaped lower sepal (vs. boat-shaped), 1–2 mm long stout spur (vs. ca. 3 mm long tubular spur), ovate dorsal petal (vs. orbicular), ca. 1 mm long dorsal auricle (vs. ca. 2.5 mm long dorsal auricle), and ellipsoid seeds (vs. reniform-discoid seeds).

Description: Annual upright herbs up to 40 cm long; stem quadrangular, canaliculated, glabrous, pale green, becoming salmon-red; extrafloral nectaries spatulate, toothed, green to salmon-red. Leaves opposite, decussate, 1–2 mm long petiolate; lamina 3–6.3 × 4.5–5 mm, lanceolate, base truncate, margin serrulate, narrowly acute at apex, adaxial surface green, pubescent, abaxial surface pale green, glabrous, midrib distinct, lateral veins obscure. Inflorescence 4–5 flowered in axillary fascicles. Bracts ca. 1 × 0.5 mm, narrowly triangular, pale green, salmon-red at apex. Flowers 7–9 mm across, white to pink, pedicellate; pedicel 1.5–2 cm long at anthesis and extending to 2.2 cm in fruiting, pale green to red-tinged, pubescent along one side; lateral sepals 2, 4.5–5.5 × ca. 0.5 mm, falcate, glabrous; dorsal petal 4.5–5.5 × ca. 5 mm, broadly ovate, glabrous, dorsally keeled, ca. 0.5 mm long mucronate; lateral united petals 2-lobed, 8–9 × ca. 4 mm, glabrous, white to pink; basal lobe ca. 2 × 1 mm, falcate; distal lobe ca. 7 × 4 mm, obovate; dorsal auricle prominent, ca. 1 mm long, strap-shaped; lower

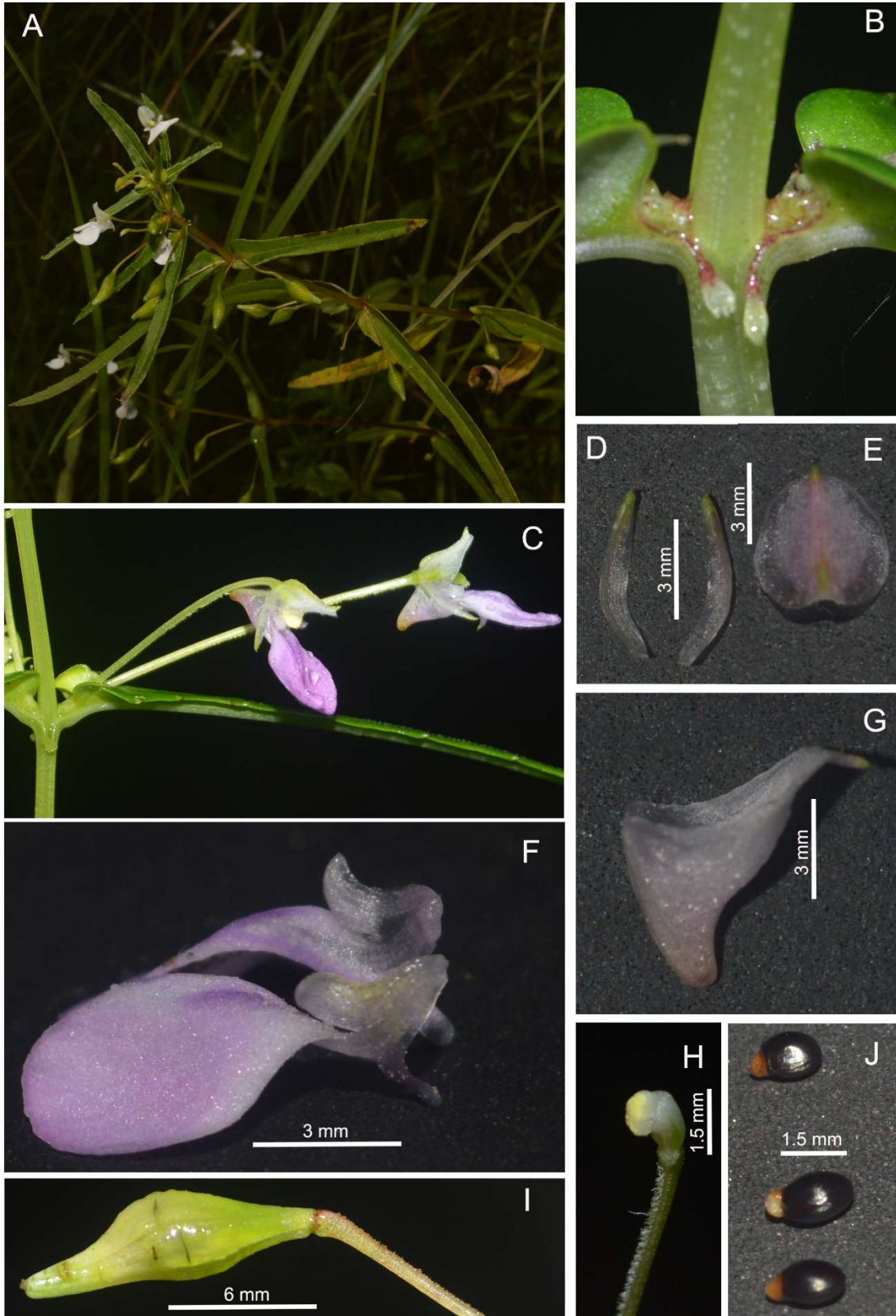


Fig. 1: *Impatiens periyarensis*. **A.** Habit; **B.** Extrafloral nectaries; **C.** Flowers; **D.** Lateral sepals; **E.** Dorsal petal; **F.** Lateral united petal; **G.** Lower sepal with spur; **H.** Stamen; **I.** Fruit; **J.** Seeds.

**Table 1.** Comparison of diagnostic morphological characters of *Impatiens periyarensis*, *I. josephia* and *I. aliciae*.

Characters	<i>I. periyarensis</i>	<i>I. josephia</i>	<i>I. aliciae</i>
Habit	Annual herbs, upright	Annual herbs, upright	Annual herbs, decumbent
Height	25–40 cm	30–55 cm	20–65 cm
Extrafloral nectaries	Green to red, spatulate and toothed	Salmon red, setaceous	Red, setaceous
Leaves	Lanceolate	Linear	Narrowly elliptic–oblong
Lamina apex	Narrowly acute	Narrowly acute	Acute-acuminate
Lamina base	Truncate	Rounded	Cuneate
Inflorescence	Axillary, 4–5-nate	Axillary, 3–5-nate	Axillary, 3–6-nate
Flower colour	Pink to white	Pink	Deep pink to purple
Pedicel	1.5–2.0 cm long	2.5–4.0 cm long	2.3–2.5 cm long
Pedicel in fruit	1.8–2.2 cm long	3.0–4.8 cm long	2.9–3.0 cm,
Lateral sepals	Falcate, glabrous	Falcate, puberulent	Linear, arching, puberulent
Lower sepal	Funnel-shaped, apex form a flap	Boat-shaped, apex cuspidate	Cymbiform, subacute
Spur	1–2 mm long, stout	c. 3.5 mm long, tubular, straight	3–4 mm, tubular–saccate, slightly curved
Dorsal petal	Widely ovate	Orbicular	Orbicular
Lateral united petal	Stipe not prominent	Stipe not prominent	Stipe prominent
Dorsal auricle	ca. 1 mm long, not filiform	ca. 2.5 mm long, filiform	ca. 5 mm long, strap-shaped
Capsule	9–12 mm long, fusiform	12–15 mm long, fusiform	13–16 mm long, ellipsoid
Seeds	10–14 in number, ellipsoid	11–15 in number, slightly reniform–discoid	11–20 in number, sub-globose

sepal 6–7.5 × ca. 3 mm, funnel-shaped, glabrous, apex acute; spur 1–2 mm long, stout, glabrous; Stamens 5, cohering above pistil; column ca. 1.5 × 2 mm, slightly curved; filaments 5, white, narrow and free up to 2/3rd their length, broad and connate at apex; anther yellow. Pistil ca. 1.5 × 1 mm; ovary narrowly oblong, glabrous, slightly curved; style rudimentary; stigma 5-toothed. Capsule 9–12 × ca. 4.5 mm, fusiform, glabrous, green seeds 9–14 in number, ca. 1.5 × 1 mm, ellipsoid, glabrous, black.

Etymology: The new species is named after the Periyar River, which is the longest river in Kerala, running through the type locality.

Phenology: Flowering and fruiting occurs during September to October.

Habitat and distribution: Grows on wet and dripping open rocky slopes in the semi-evergreen forests at elevations of 800–900 m. Presently, it is known only from the hill ranges of Idukki district in Kerala.

Notes: *Impatiens periyarensis* is similar to *I. josephia* in its habit, nature of inflorescences, shape of the lateral sepals, shape of the basal lobe of the wing petals and organisation of the staminal column. However, it differs from *I. josephia* by various vegetative and floral characters which are depicted in Table 1.

Impatiens aliciae C.E.C. Fisch., Bull. Misc. Inform. Kew 1934(9): 389 (1934) **Fig. 2**

Type: INDIA. Kerala, Travancore Hills, near Munnar, down the Ghat, 5000 ft., September 1933, *Barnes 617* (holotype K!, K000381735 image!)

Description: Annual decumbent branched herbs up to 65 cm long; stem quadrangular, canaliculated, glabrous, salmon-red; extrafloral nectaries setaceous, salmon-red. Leaves opposite, decussate, 1–2 mm long petiolate; lamina 3–12 × 0.5–0.9 cm, linear or narrowly elliptic, base cuneate, margins distantly serrate, the basal 1–3 teeth on either side elongated and glandular, narrowly acute at apex, minutely papillose-hispidulous

and dark-green above, glabrous and glaucous below, midrib sub-prominent below, lateral nerves indistinct. Inflorescence 3–6 flowered in axillary fascicles. Bracts minute, ca. 0.5 × 0.5 mm, linear, salmon-red. Flowers 10–12 mm across, deep pink, pedicellate; pedicel 2.3–2.5 cm long at anthesis and extending to 3 cm in fruits, red, with a line of pubescence on one side; lateral sepals 2, 5–6 × ca. 1 mm, linear-oblong, acute, puberulent; dorsal petal 5–6 × ca. 6 mm, orbicular, dorsally keeled and pubescent, apex mucronate; lateral united petals 2-lobed, 12–14 × ca. 6 mm, glabrous, deep pink, stipe and basal lobe with red stripes; basal lobe ca. 6 × 1 mm, falcate, acute at apex; distal lobe ca. 9–10 × 6 mm, broadly obovate, deep-pink with a splash of purple-crimson streaks on the inner side; dorsal auricle ca. 5 mm long, about half as long as the wing, strap-shaped, its edges folded in to form a tube near the spoon-shaped apex, the two auricles descending into the spur with their concave sides facing each other; lower sepal 7–8 mm long, cymbiform, subacute at apex, glabrous; spur ca. 3 mm long, tubular-saccate, stout, slightly curved; Stamens 5, cohering above pistil; column ca. 2 × 1 mm; filaments 5, pink, narrow and free up to 2/3rd their length, broad and connate at apex; anther pink. Pistil ca. 1.5 × 1 mm; ovary ellipsoid, glabrous, slightly curved; style rudimentary; stigma 5-toothed. Capsule 13–16 × ca. 5 mm, ellipsoid, glabrous, green; seeds 10–20 in number, ca. 2–3 × 2 mm, subglobose, black, glabrous.

Phenology: Flowering and fruiting occurs during September to October.

Habitat and distribution: Grows on wet and dripping open rocky slopes and also in marshy places in the evergreen forests at an elevation of 350–600 m in Idukki, Kerala.

Notes: *Impatiens aliciae*, presumably a narrow endemic species, created confusion among botanists because of the lack of collections after its type collections (Bhaskar, 2012). In many occasions other

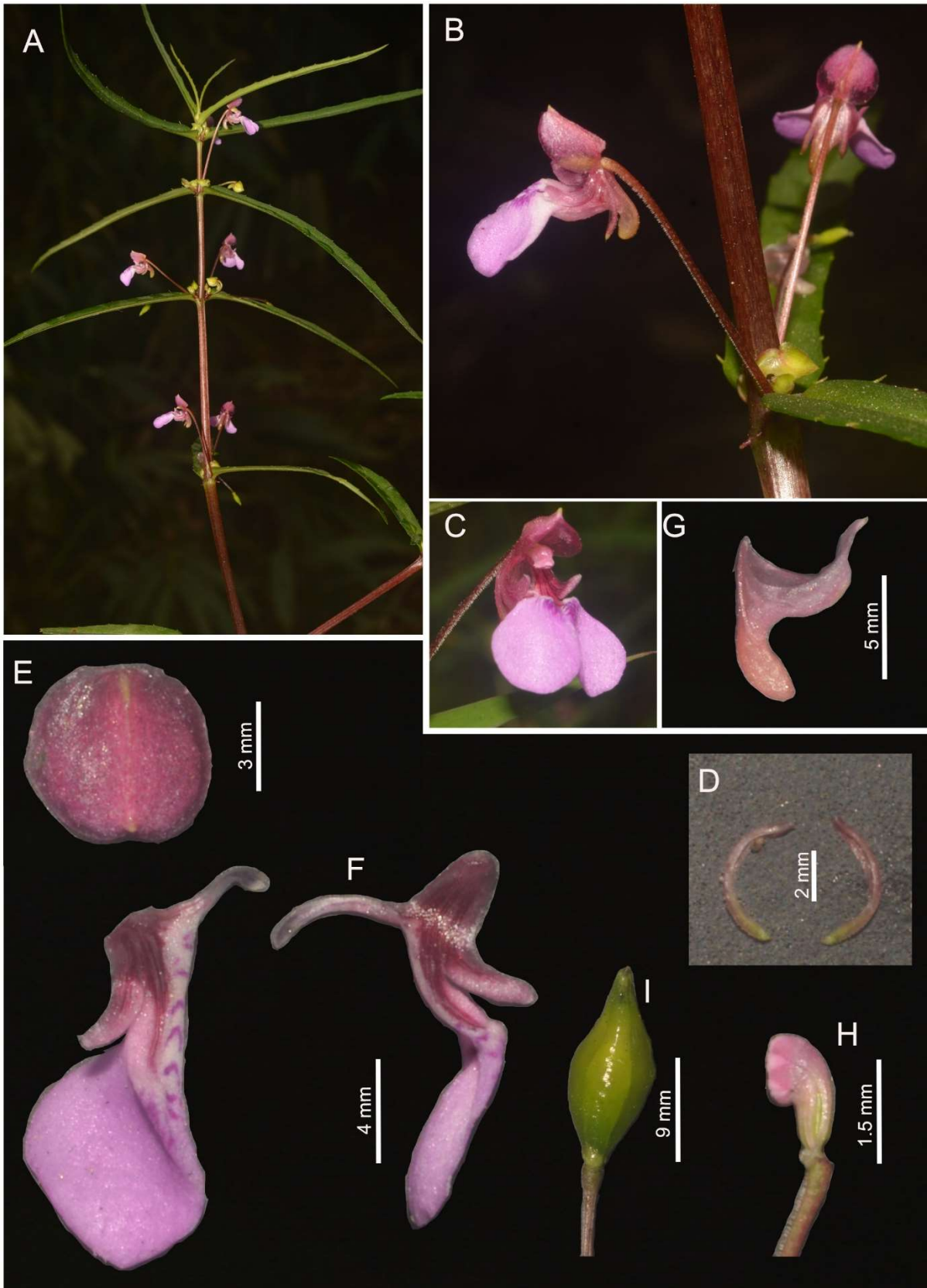


Fig. 2: *Impatiens aliciae*. **A.** Flowering branch; **B.** A pair of flowers; **C.** Flower front view; **D.** Lateral sepals; **E.** Dorsal petal; **F.** Lateral united petal; **G.** Lower sepal with spur; **H.** Stamen; **I.** Fruit.



species have also been treated as *I. aliciae* (Saldanha, 1996, Efloraofindia Google Group, 2007) by mistake. *Impatiens aliciae* differs from similar species by its prominently stipitate lateral united petals, falcate basal lobe of lateral united petals, ca. 3 mm long, blunt, slightly curved spur and ca. 5 mm long strap-shaped dorsal auricle with edges folded in to form a tube. According Bhaskar (2012) it is allied to *I. tenella* - *I. debilis* - *I. lenta* complexes. However, Bhaskar (2012) himself has clearly presented how *I. aliciae* differs from species of this complex. Our study on the other hand has recognised that *I. aliciae* is more close to *I. josephia* rather than any other species and a comparative account on the diagnostic features of these species are given in Table 1.

Specimens examined: India, Kerala, Travancore Hills, near Munnar, down the Ghat, 5000 ft., September 1933, *Barnes 617* (holotype K! K000381735 image!); Travancore, Kottayam-Munnar New Ghat Road, 2–3000 ft., September 1933, *Barnes 618* (K! K000381734 image!); Idukki, Valara, 400 m a.s.l., 26 August 2017, *Binca Mani 68669* (RHT!).

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A new species of *Strobilanthes* (Acanthaceae) from the Western Ghats, India

Sinjumol THOMAS¹, Bince MANI^{2*}, Susai John BRITTO³, Annavi veettil Krishna Pillai PRADEEP⁴

1. Department of Botany, Carmel College, Mala, Thrissur–680732, India.

2. Department of Botany, St. Thomas College Palai, Kottayam–686574, India.

3. The Rapinat Herbarium and Centre for Molecular Systematics, St. Joseph's College (Autonomous), Tiruchirappalli–620002, India.

4. WWI Innovative Solutions, Kottayam–686576, Kerala, India.

*Corresponding author's email: binsnm@gmail.com

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ABSTRACT: *Strobilanthes scopulicola*, a new species from the collections of the high altitude montane grasslands of Nilgiri Biosphere Reserve in Western Ghats of India is described and illustrated. Photographs, details of phenology, distribution, pollen morphology and similarity with related species were also provided.

KEY WORDS: Acanthaceae, India, pollen, *Strobilanthes lanata*, *S. lawsonii*, taxonomy, Wayanad, Western Ghats.

INTRODUCTION

The genus *Strobilanthes* Blume consists of ca. 450 species (Mabberley, 2017) confined to the south and southeast of Asia and Melanesia (Carine and Scotland, 1998; Carine and Scotland, 2002). In India, the genus includes ca. 150 species (Karthikeyan *et al.*, 2009), of which more than 60 occur in south India alone (Carine and Scotland, 2002; Venu, 2006), however, recent findings suggest the unexplored diversity of *Strobilanthes* in south India (Scotland, 1998; Santhosh Kumar *et al.*, 2002; Carine *et al.*, 2004; Gopalan and Chithra, 2008; Mascarenhas and Janarthanam, 2013; Sasidharan *et al.*, 2016; Josekutty *et al.*, 2016, 2018; Augustine *et al.*, 2017; Biju *et al.*, 2017; Thomas *et al.*, 2018, 2019a, 2019b, 2019c, 2020). During the systematic study of *Strobilanthes* from south India for the past twelve years, the authors collected specimen of *Strobilanthes* which grew along the open rocky cliffs in the high altitude montane grasslands of Nilgiri Biosphere Reserve. The plant possessed features such as ovate to lanceolate-ovate leaves, much elongated and uninterrupted to interrupted spikes with tawny indumentum, large, campanulate and deep blue corollas and apically pubescent ovaries. Closer examination of the specimen revealed similarity to *S. lawsonii* Gamble and *S. lanata* Nees. Furthermore, comparison of the specimens with herbarium specimens in India and abroad and critical study of relevant literature revealed that it did not match with any of the known species of *Strobilanthes* including *S. lawsonii* and *S. lanata* (Carine *et al.*, 2004; Venu 2006). Therefore, we describe it as a new species.

TAXONOMIC TREATMENT

Strobilanthes scopulicola A.K. Pradeep, Sinj. Thomas, B. Mani & Britto, *sp. nov.* **Fig. 1**

Type: INDIA. Nilgiri Biosphere Reserve, Kerala, Wayanad, Meppadi, 1750 m a.s.l., 11°29'17" N, 76°06'49", 15 December 2014, Pradeep A. K. & Bince Mani 68241 (holotype, RHT!).

Diagnosis: *Strobilanthes scopulicola* is allied to *S. lawsonii* and *S. lanata*, but differs by ovate to lanceolate-ovate leaves (not ovate or elliptic), pubescence on adaxial leaf surface (not glabrous), bracts with acute apex (not acuminate) and adaxial pubescence (not glabrous), widely elliptic corolla lobes (neither ovate nor triangular or orbicular), stamina with villous filaments (not sparse hairy), glabrous stigma (not pubescent) and subprolate pollen grains with two ribs completely encircling the grain (neither prolate nor all the ribs fused at poles).

Description: Erect, isophyllous, semelparous shrubs, up to 2.5 m high; stem terete, lenticellate, profusely branched, covered with dense tawny hairs. Leaves opposite, slightly asymmetrical; petiole 10–35 mm long, slightly canaliculate, brown tomentose; lamina ovate to lance-ovate, 70–155 × 22–63 mm, coriaceous, base shortly decurrent, apex long acuminate, up to 50 mm long, margin entire, dense tawny woolly beneath, pubescent on veins above; lateral veins 8–13 pairs, impressed above, raised beneath. Inflorescences axillary or terminal, 65–110 × 4–5 mm, narrow uninterrupted to interrupted compound spikes; peduncle terete, branched, covered with dense tawny indumentum; bracts ovate, ca. 7 × 4 mm, shorter than calyx at anthesis, base rounded, apex acute, margin entire, abaxial surface and margin with tawny woolly indumentum, adaxial surface pubescent; bracteoles ca. 6 × 1 mm, linear, brown woolly outside. Calyx 6–9 mm long, 5-lobed, tube 3–5 mm long, lobes ca. 3 × 1 mm, narrowly acute, unequal with two lobes shorter than the rest, woolly outside and pubescent inside, glandular pubescent in infructescence. Corolla blue, 27–32 mm long, slightly curved and widening from



Fig. 1: *Strobilanthes scopulicola*. **A.** Habit; **B.** Leaves: adaxial and abaxial view; **C–D.** Inflorescence; **E.** Bract: adaxial surface; **F.** Bract: abaxial surface; **G.** Bracteole and calyx; **H.** Corolla; **I.** Corolla split open showing the included stamens; **J.** Pistil (inset: ovary with apical pubescence); **K.** Inflorescence; **L.** Young fruit; **M.** Seeds.

**Table 1.** Comparison of pollen characteristics of *Strobilanthes scopulicola*, *S. lawsonii* and *S. lanata*.

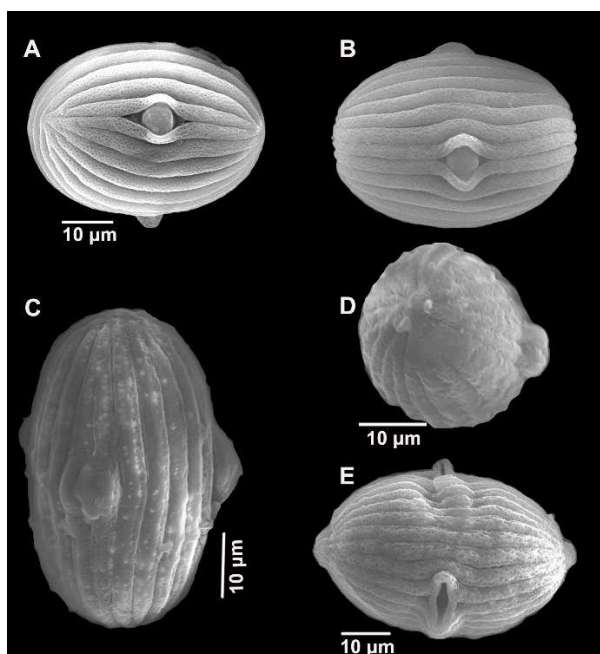
Species	Pollen type†	Equatorial view	P (µm)	E (µm)	P:E ratio	Ribs (nos.)
<i>S. scopulicola</i>	2	subprolate	43–45	34–36	1.25	21–23
<i>S. lawsonii</i> †	1	prolate	54–61	40–47	1.30	21–27
<i>S. lanata</i> †	1	prolate	72–76	43–50	1.70	24–28

†Type 1: all ribs fuse at the poles; type 2: two or three ribs completely encircle the poles (Carine and Scotland, 1998).

Table 2. Diagnostic characters of *Strobilanthes scopulicola* and allied taxa.

Characters	<i>S. scopulicola</i>	<i>S. lawsonii</i> †	<i>S. lanata</i> †
Adaxial leaf indumentum	pubescent	glabrous	glabrous
Spikes at anthesis	uninterrupted to interrupted	interrupted	uninterrupted
Bract apex	acute	acuminate	acuminate
Calyx	6.0–8.5 mm long	5.6–6.5 mm long	7.1–13.0 mm long
Corolla lobes shape	widely elliptic	ovate to broadly triangular	ovate to sub-orbicular
Filament pubescence	dense villous throughout	sparse white hairs for 0.7–0.8 of length	pubescent below for more than half the length
Pubescence on ovary apex	long hairy pubescent	glabrous	sparsely pubescent
Pubescence of style	pubescent throughout	sparsely pubescent	sparsely pubescent
Pubescence of stigma	glabrous	pubescent	pubescent

†Carine *et al.* (2004).

**Fig. 2:** SEM micrographs of pollen grain of *Strobilanthes scopulicola* (A–B), *S. lawsonii* (C–D) and *S. lanata* (E).

basal tube, 5-lobed; tube 6–7 mm long, glabrous, white; throat campanulate, 16–18 mm long, deep blue, with dense short pubescence on outer surface and long white hairs on inner surface; lobes equal, 5–7 × 6–7 mm, widely elliptic, deep blue, apex rounded to obtuse, with dense pubescence on outer surface. Stamens 2, included, basally attached to corolla; filaments 10–11 mm long, villous throughout; anthers ca. 2 × 1 mm, bithecate. Ovary ca. 2 × 1 mm, apex pubescent, 2-locular with two ovules per locule; style 18–20 mm long, filiform, pubescent throughout; stigma linear, ca. 2 mm long, simple, glabrous. Infructescence 100–200 × 10–20 mm, densely glandular hairy; capsule 20–23 × 7–8 mm, elliptic, glabrous. Seeds 2, 5.0–6.5 × 5.0 mm, tawny lanate.

Etymology: The specific epithet “scopulicola” refers to the habitat rock cliffs of high altitude montane grasslands where the new species is exclusively found.

Phenology: Flowering November–January; seed dispersal from mid-April onwards.

Habitat and distribution: *Strobilanthes scopulicola* grows along rocky cliffs in grasslands at an elevation of 1600–2050 m a.s.l. in the northern part of the Nilgiri Biosphere Reserve.

Pollen Morphology: Pollen grains are ellipsoid (Fig. 2A–B), tricolporate and contain pseudocolpi. The pollen is subprolate in outline and exine divided into longitudinal ribs which are close, straight, tectate and two of them completely encircle the pollen. Other pollen features are also given for descriptive purposes (Table 1).

Notes: The new species is closely related to *S. lawsonii* by similarities such as tawny indumentum on leaf, stem and inflorescence, leaves with acuminate apex, narrow uninterrupted or interrupted spikes, bracts being shorter than calyx, campanulate corolla and included stamens. The new taxon also shows relationships with *S. lanata* in characters such as entire leaves with dense tawny woolly abaxial indumentum, campanulate corolla and included stamens. However, the new species could easily be set apart from both taxa by several vegetative and floral features (Fig. 3; Table 2).

The variability of pollen morphology in *Strobilanthes* is a potentially useful character to delimit taxa in this group (Carine and Scotland 1998, Deng *et al.* 2006). The close allies of the new taxon, such as *S. lawsonii* and *S. lanata* belong to pollen type 1 (Carine and Scotland 1998) in which the ribs fuse at the poles and none of them completely encircle the pollen. The pollen of *S. scopulicola* belongs to type 2 in which some of the ribs completely encircle the poles. A comparison of pollen characteristics with the related taxa, *S. lawsonii* and *S. lanata*, is presented (Fig. 2 C–E, Table 1).



Fig. 3. Flowering branch of *Strobilanthes scopulicola* (A) and *S. lanata* (C) and image of the type specimen of *S. lawsonii* (© the Board of Trustees of the Royal Botanic Gardens, Kew) (B)

Specimens examined: *Strobilanthes scopulicola*: INDIA. Nilgiri Biosphere Reserve, Kerala, Wayanad, Meppadi, 20 February 2015, Pradeep A. K. 68242 (RHT! TAI!); 25 April 2015, Pradeep A. K. 68414 (RHT!). *Strobilanthes lawsonii*: INDIA. Tamilnadu, Nilgiri Distr., Sispara Ghat, November 1883, Gamble 13387 (K! lectotype); Sispara, June 1884, Gamble 14252 (K!); 19 November 1890, Anonymous s. n. (MH!); Coonoor, Sims Park, 16 April 1900, Bourne s. n. (K!). *Strobilanthes lanata*: India. Tamilnadu, Nilgiri Distr., Sispara, 25 April 1870, Beddome 119 (K!); Sispara Ghat, Anonymous s. n. (MH!); Botanic Garden Ooty, 15 April 1950, Curator s. n. (MH!).

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A PRELIMINARY STUDY ON THE MEDICINAL PLANTS OF ANNALLUR KOLE LANDS, CHALAKUDY, THRISSUR, KERALA

¹Bindhu.K.B.,² Anjana.K.S.,³ Fathima Parveen

¹ Assistant professor,² BSc Botany student,³ BSc Botany student

¹ Department of Botany,

¹ Carmel Collge, Mala, Thrissur, Kerala

Abstract:

A work was carried out to study the diversity of medicinal plant at Annallur Kole lands of Chalakudy, Thrissur. The main aim of the study was to identify the medicinal plants of the kole land, their uses, wetland plant diversity, importance of wetlands and to create awareness about it. Work was done from the period of September to December 2019. Frequent field visits were made, plants were collected and identified with the help of standard flora and with the help of experts from the field of taxonomy. It was observed that the area is rich in plant diversity. We observed 53 plants belonging to 25 families. The medicinal use of each plant was also examined and tabulated. In the present analysis of kole land flora, members of the family Asteraceae were predominant with eight genera then Convolvulaceae followed by Fabaceae with five and four members respectively. Then by Cyperaceae, Amaranthaceae, Onagraceae, Acanthaceae, Euphorbiaceae and Malvaceae members were also there. The data compiled in this study highlights the diversity and abundance of plants with medicinal properties in this wetland system. This necessarily leads to create a better understanding of medicinal plants of kole lands to the present community.

Index Terms – Wetland, medicinal plants, diversity, koleland, taxonomy.

I. INTRODUCTION

Kole wetlands are a type of wetland which support varied spectrum of biodiversity. They form vital ecosystems providing response for the livelihood concerns of thousands of inhabitants in and around this area. Several species of aquatic and semi aquatic medicinal flora make use of the outstanding habitat Kole wetland ecosystem. The plants of this area are being used by local community for healing purposes. More than that the varying conditions due to anthropogenic activities these flora are very subtle to fluctuations in the normal physiochemical parameters of the wetland, results in the extirpation of these plants. This may lead to the ultimate end of the medicinal products. Considerable attempts have to be made to record the availability of medicinal plants and to spotlight the known therapeutic properties of the wetland plants of this important zone. It was reported that the local inhabitants have been using wetland plants against many diseases traditionally. We have to realize the importance of traditional medicine which provides about 80% of health service to world population to an extent that deserves (Marini, 1980). India, has greater potentials to increase its share in the world market, as having excellent traditional knowledge in the herbal medicine. In the form of food, fodder and medicine, plants of kole wetland ecosystem played an engrossing role in the life of humankind in earlier days. But the changed life style, reduced the worth of these wetland plants, and they are treated as weeds. Protection and conservation of wetland is an important matter.

In spite of forming the rich repositories of various plant species, attempts have not been undertaken to itemize the food values and medicinal uses of them. It is a matter of urgent need to record the present status of medicinal plants in this unique ecosystem for their conservation and utilization for sustainable development. In this context a preliminary study has been carried out for the documentation of availability and medicinal potential of plants that grow as weeds in Annallur Kole lands.

II. LITERATURE REVIEW

Many works were carried out by scientists from different parts of the world on various aspects of wetland plants which clearly indicate the importance of wetland plants. In India, Kerala is having the largest area under wetlands (Nayar and Nayar, 1997). Using IRS satellite data Nair and Sankar (2002) recently mapped the wetland systems of Kerala and reported that the state has a total of 217 wetland units out of which only 157 units are having an area greater than 56.25ha.

In the Kole land area moderate climatic conditions prevailed. A minimum temperature of 21°C and a maximum of 38°C has been recorded in this area. Air is humid (85-95% during June-September and 70% during January). The southwest and North-west Monsoons are the rainy seasons in Kole lands.

Kole lands are having rich in floristic and faunal diversity than any other fresh water ecosystems. All taxonomic groups including algae, mosses, ferns and flowering plants including many medicinal plants are represented in such areas.. Ecological status of an ecosystem can be evaluated with a knowledge of the major plant communities and their relative importance. depending on the availability of water many aquatic macrophytes grows either submerged or floating on the surface, continuously or periodically. They provides habitat and refuge of the aquatic communities and contribute biomass and nutrients to various trophic levels in the ecosystem, there by helping to maintain the structure and function of aquatic ecosystem. Changes in the community composition or alteration in the abundance of individual species provide valuable information on how and why an ecosystem might be changing (Scott et al., 2002). According to Kelly and Whitton, 1998 a progressive change in species composition can result in the eventual loss of species diversity due to eutrophication. Beside this they also favour periphytic growth, enrich various aquatic fauna and serve as a breeding ground for associated fauna (Mitra, 1997).

Jayson and Sivaperuman (2005), stated that the Kole wetlands act as feeding, roosting and breeding ground for many species of migratory and resident birds and they reported 182 species of birds, 13 species of fishes from the Thrissur Kole wetlands.

III. RESEARCH METHODOLOGY

Study area

The present study is based on the wetland plants collected from Annallur Kole land. Collection was done during the period of September-December 2019. Annallur is a village of Thrissur District near Kottat, Chalakkudy. And this place is 6 km away from Chalakkudy National Highway. The factory Thomson Tiles is running near to this paddy field. The main cultivation of this area is paddy. And the non cultivated area is rich with plant diversity including both aquatic and terrestrial. In this study an attempt was carried out to explore wetland diversity of Annallur paddy field during post monsoon season.

Collection of specimen

The plants were collected from the Annallur Koleland and observed as well as the colour photographs were taken with the help of digital camera in their material habitat. The specific plants in that area were collected along with their flowers taken for further analysis and herbarium preparation. The specimens collected from the wetland were brought in to the laboratory for further analysis. The plants were examined starting from stalk through the calyx corolla, androecium up to the tips of stigma using hand lens. Then record the observed characters in a note book. Flowers were sectioned with help of razor or sharp blade, one horizontally and the other down the middle, for know about placentation and to complete floral diagram and for understanding the status.

Preparation of field book

During the collection, the specimens were collected and tagged within the field number. Filed observation such as habitat, flower colour etc. were entered in the field book. The specimens of appropriate size with relevant parts were collected from the field for herbarium preparation.

Identification of family

On the basis of examined characters, the families of the specimens were identified .As well as the software “flowering plants of Kerala ver.2.0 (Dr.sasidharan , KFRI. Peechi), under biodiversity portal (India biodiversity.org.) and experts in the field of taxonomy were also helped in the identification of plant specimens.

Preparation of herbarium

The collected specimens, were cut or dug, and pressed as soon as possible. After that specimens placed carefully on a pressing sheet. (Newsprint sheet or a blotter) without no folding or overlapping of parts .After drying and pressing specimens were affixed on the herbarium sheet. Then the binomial, family, habitat etc. were recorded on the sheet.

IV. RESULTS AND DISCUSSION

Kole lands in Annallur serve as an excellent habitat for numerous medicinal herbs which can be harvested for economic benefits. This investigation on the availability and abundance of medicinal herbs in the Annallur kole revealed the presence of 44 species under 40 genera and 22 families (Table 1). In the present analysis of kole land flora, members of the family Asteraceae were predominant with Eight genus and Convolvulaceae followed by Fabaceae and convolvulaceae with five and four members respectively.. Then by Cyperaceae, Amaranthaceae, onagraceae ,Acanthaceae, Euphorbiaceae Malvaceae members are also there. Among this three ferns were also noticed during the study time. *Ludwigia octovalvis* *Ludwigia adscendens* ,*Merrimia hederacea* ,*M. tridentata* ,*Ipomea aquatic*, *Hygrophylla schulli* ,*Kyllinga squamulata* *Monochoria vaginalis*, and *Schoenoplectus articulatus* are frequent in all seasons in the study area. The study area contains saline tolerant species like *Acanthus ilicifolius* with different medicinal values were also come across. The observed species were found to be used in in curation of gastrointestinal disorders, respiratory ailments, dermatological snags, urinogenital illnesses, cardiovascular problems and neuro disorders (Table 1). They were also used for different applications including decoction, extraction, infusion and paste preparation. It was also observed that methods of application of medicine like oral administration, local application, inhalation or smoking and massaging is in practice.

The data compiled in this study highlights the diversity and abundance of plants with medicinal properties in this wetland system. So it is necessary to create a better understanding of medicinal plants of kole lands to the present community. We can change the status of the plants from worst weed to useful medicines for mankind by providing basic information to the local community on the medicinal attributes of these plants. The economic importance of river vegetation of Kerala including both wetland species and bank species was analyzed Maya *et al.*, (2003). A review on the utility of Indian wetland plant species as food and medicine by incorporating the traditional knowledge of local communities was made by Swapna *et al.*, (2011).

People have open access to collect and utilize the aquatic medicinal plants in kolelands as most of them are grown in wild and them. Beside this the koleland plants of the region can provide high income generating opportunities to local communities.

Almost all the medicinal plants found in Annallur kolelands are commonly seen in rivers, ponds and paddy fields all over Kerala, however, kolelands offer plenty of space for its feasible agriculture and sustainable exploitation. Some of the therapeutic usages of such species are very unique to the traditional medicinal knowledge system of the locality.

According to Kairo *et al.*, 2000, major impediments in the protection of wetland resources are the lack of community participations in management efforts, source of revenue, and dearth of awareness amongst decision makers on the exact values of

wetland. Therefore in this kole wetland region for sustainable management a complete and comprehensive management strategy, based on ethnic, ecological and financial principles, is need to be planned by the whole participation of local stakeholders

Table 1-Table showing the name family and uses of plants reported from the Koleland area

NO	NAME	FAMILY	MEDICINAL USE
1	<i>Ludwigia octovalvis</i>	Onagraceae	Used in the treatment of diarrhoea, dysentery, nervous diseases
2	<i>Ludwigia adscendens</i>	Onagraceae	A decoction of the aerial parts is used as a treatment for dysentery, fever, cough and ophthalmia.
3	<i>Ipomea alba</i>	Convolvulaceae	The whole herb is used in treating snakebite
4	<i>Merrimia hederacea</i>	Convolvulaceae	Juice of the leaves, used to heal cracks in the hands and feet
5	<i>Merrimia tridentata</i>	Convolvulaceae	A decoction of the whole plant -various ophthalmias.
6	<i>Ipomea aquatica</i>	Convolvulaceae	The young shoots used by diabetic patients
7	<i>Cuscuta chinensis</i>	Convolvulaceae	A lotion from the stems for sore heads and inflamed eyes.
8	<i>Ziziphus jujuba</i>	Rhamnaceae	Used for improving muscular strength and weight, for preventing liver and bladder diseases and stress ulcers.
9	<i>Physalis minima</i>	Solanaceae	Appetizing, tonic, diuretic, laxative, useful in inflammations, enlargement of the spleen and abdominal troubles.
10	<i>Polygonum pencilvanicum</i>	Polygonaceae	For hair-blackening, liver and kidney-tonifying and anti-aging effects as well as low toxicity.
11	<i>Eicchhornia crassipes</i>	Pontederiaceae	The weed biomass can be used for antimicrobial, antifungal activities
12	<i>Monochoria vaginalis</i>	Pontederiaceae	Plant is considered alterative, tonic and cooling. Juice of leaves is applied to boils.
13	<i>Gomphrena decumbens</i>	Amaranthaceae	Antiasthmatic, abti oxidant properties
14	<i>Alternanthera philoxeroides</i>	Amaranthaceae	n extract of the plant is used medicinally in India to treat 'female diseases
15	<i>Lindernia diffusa</i>	Scropulariaceae	Leaf paste with lemon juice is given orally to cure excess bile secretion; also applied externally on ringworm and boils.
16	<i>Urena lobata</i>	Malvaceae	The leaves are diuretic, emollient, refrigerant, styptic, vulnerary
17	<i>Sida accuta</i>	Malvaceae	decoction of the whole plant is used as a treatment for feversThe juice of the plant is used to treat indigestion
18	<i>Commelina diffusa</i>	Commelinaceae	The leaves are diuretic and febrifuge The crushed leaves and stems are used as a remedy for irregular menstruation
19	<i>Cleome viscosa</i>	Capparadaceae	Anthelmintic, antimicrobial, analgesic, antiinflammatory, immunomodulatory, antipyretic and psychopharmacological, antidiarrheal
20	<i>Emelia sonchifolia</i>	Asteraceae	A tea made from the leaves is used in the treatment of dysentery.
21	<i>Vernonia cinerea</i>	Asteraceae	Seeds Cures diseases caused by roundworms and threadworms, coughs, flatulence, intestinal colic, and other chronic skin-diseases.
22	<i>Sphagneticola trilobata</i>	Asteraceae	A strong decoction of the whole plant is used to treat chest colds. Combined with Lantana camara, as a tea or syrup, as a remedy for colds
23	<i>Tridax procumbens</i>	Asteraceae	The leaves are antiseptic, haemostatic and parasiticide.
24	<i>Mikania michrantha</i>	Asteraceae	Juice of leaves is applied to boils.
25	<i>Sphaeranthus indicus</i>	Asteraceae	widely used in Ayurvedic system of medicine to treat vitiated conditions of epilepsy, mental illness, hemicrania, jaundice, hepatopathy, diabetes, and skin diseases
26	<i>Phyllanthus amarus</i>	Euphorbiaceae	Phyllanthus amarus is widely used as a medicinal plant and is considered to be a good tonic, diuretic and febrifuge
27	<i>Bridelia ovata</i>	Euphorbiaceae	The leaves are purgative,Another report says that they are a mild laxative.
28	<i>Alysicarpus vaginalis</i>	Fabaceae	decoction of the roots is used as a treatment against coughs
29	<i>Senna tora</i>	Fabaceae	The seeds are diuretic and purgative.The leaves are purgative
30	<i>Mimosa pudica</i>	Fabaceae	The leaves are bitter, mildly sudorific, tonic.A leaf tincture is given by teetotallers to drunkards to remedy drunkenness
31	<i>Centrosema molle</i>	Fabaceae	medicine as a toxic, alternative, diaphoretic, blood purifier, in rheumatism
32	<i>Setaria lucopila</i>	Poaceae	The germinated seed of yellow-seeded cultivars is astringent, digestive, emollient and stomachic
33	<i>Eragrostis tenella</i>	Poaceae	This Plant has an extensive property of acting as anticancerous, antimicrobial and antioxidant agents
34	<i>Ficus sps</i>	Moraceae	Ficus species is used medicinally, mainly to cover and cure

			wounds, boils and sores, but also as an antirheumatic
35	<i>Acanthus ilicifolius</i>	Acanthaceae	Diuretic and is used as a cure for dropsy and bilious swellings.
36	<i>Hygrophylla schulli</i>	Acantahceae	The plant is often used in traditional medicine, being valued especially as a diuretic.
37	<i>Kyllinga squamulata</i>	Cyperaceae	The leaves, stems and rhizomes are analgesic, antiinflammatory, antimalarial, decongestant, diuretic, febrifuge and sudorific.
38	<i>Cyperus rotundus</i>	Cyperaceae	Traditional herbal medicine used widely as analgesic, sedative, antispasmodic, antimalarial, stomach disorders and to relieve diarrhoea
39	<i>Schoenoplectus articulatus</i>	Cyperaceae	Excellengt source of phenolic compounds and anti oxidants.
40	<i>Ichnocarpus frutescens</i>	Apocyanaceae	Whole plant is used as tribal medicine in atrophy, bleeding gums, convulsions, cough, delirium, heamaturia etc.,
41	<i>Corchorus olitorius</i>	Tiliaceae	Folk remedy for aches and pains, dysentery, enteritis, fever, pectoral pains, and tumors.
42	<i>Hydrolea zeylanicus</i>	Hydrophyllaceae	The leaves, beaten into pulp and applied as a poultice, are considered to have a cleansing and healing effect on neglected and callous ulcers.
43	<i>Ceratopteris thalictroides</i>	Pteridaceae	In traditional medicine , the plant is used as a poultice for skin problems, as a styptic to stop bleeding.
44	<i>Pteris vittata</i>	Pteridaceae	The leaves possess astringent properties , and a decoction of the fresh leaves is given in dysentery
45	<i>Salvinia molesta</i>	Salviniaceae	Known for antioxidant properties, flavonoids, free radicals and phenolic compounds,
46	<i>Poa bulbosa</i>	Poaceae	Good fodder for animals
47	<i>Leucas aspera</i>	Lamiaceae	Antifungal, prostaglandin inhibitory, antioxidant, antimicrobial, antinociceptive and cytotoxic activities
48	<i>Hyptis suaveolens</i>	Lamiaceae	Possess antifertility, antiinflammatory, and antiplasmodial properties.
49	<i>Ageratum conyzoides</i>	Asteraceae	Utilized for the treatment of various ailments, such as burns and wounds, headaches
50	<i>Synedrella nodiflora</i>	Asteraceae	<i>Synedrella nodiflora</i> leaves can be used as Pregnant Mare Serum Gonadotrophin supplier in animal husbandry to improve reproductive parameters in females.
51	<i>Desmodium triflorum</i>	Fabaceae	Analgesic and anti-inflammatory activities
52	<i>Nymphaea nouchali</i>	Nymphaeaceae	Used for the treatment of diabetes, liver disorders, urinary disorders, menorrhagia, blenorrhagia, menstruation problem
53	<i>Cyperus polystachyos</i>	Cyperaceae	Rhizomes are considered astringent, diaphoretic, diuretic, sedative, stimulant, stomachic, vermifuge, tonic and antibacterial. T

Photographs of plants reported from the study area



Ludwigia octovalvis



Ludwigia adsc



Ipomea alba



Merrimia hederacea



Pteris vittata



Ziziphus jujuba



Polygonum pencilanicum



Physalis minima



Mikania michrantha



Eicchornia crassipes



Gomphrena decumbens Merrimia tridentata A. philoxeroides Lindernia diffusa Sida accuta



Commelina diffusa Cleome viscosa Urena lobata Emelia sonchifolia Vernonia cinerea



Phyllanthus amarus Ficus sps Senna tora Sphagneticola Trilobata Tridax procumbens



Salvinia molesta Schoenoplectus articulatus Kyllinga squamulata Cyperus rotundus Eragrostis tenella



Ipomea aquatica Sphaeranthus indicus Alysicarpus vaginalis Ichnocarpus frutescens Corchorus olitorius

*Mimosa pudica**Centrosema molle**Bridelia ovata**Hygrophylla schulli**Hydrolea zeylanicus**Monochoria vaginalis**Cuscuta chinensis**Setaria lucopila**Acanthus ilicifolius**Ceratopteris thalictroide**Poabulbosa**Hyptis suaveolens**Leucas aspera**Ageratum conyzoides**Synedrella nodiflora**Desmodium triflorum**Nymphaea noucha**Cyperus polystachyos*

V.CONCLUSION

As a conclusion we can say that this study is a preliminary step for the identification of valuable medicinal plants in the wetlands of Annallur area. Along with the understanding of the traditional medicines and beliefs we have to develop scientific awareness for protection and conservation of our wetlands, so this study was conducted. High value medicinal plants are in pressur and their biodiversity is in high risk due to huge demand for plant derived drugs. From this minor study 50 genus of wetland plants belonging to 25 families were recorded to be used by the traditional medicine practitioners. In developing countries increasing populations, urbanization and deforestation are contributing to species endangerment. Over exploitation and unsustainable development leads to the decrease or elimination of medicinal plants. These medicinal plants are easily accessible and affordable to rural community and such remedies have certain advantages also. The wetlands have a vast wealth of, of medicinal plants which are sources useful compounds. On the other hand loss of important floral diversity also leads to declining of it. Hence conservation of floral diversity will be important tool to sustain and carry such important knowledge to the future generation. The flora is the most important factor to maintain the biodiversity of an area.

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Review Article

A review on major and minor Diseases affecting *Piper nigrum* L.: The king of spices

Johnson, Riya and Kochuthressia, K. P.

Department of Botany, Carmel college, Mala, Thrissur, Kerala, India

Corresponding Author: riya.johnson7@gmail.com

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ABSTRACT

Pepper (*Piper nigrum*. Linn) (Piperaceae) is considered as the “King of spices”, a widely used spice that has been extensively explored for its biological properties and its bioactive Phyto compounds. However, crop loss through the attack of pests and pathogens is a big challenge for producers and scientists. Eradication of diseases on infected farms is impossible. Therefore, it seems a need to possess enough knowledge regarding different pests and pathogens. The identification of pest and pathogen, its occurrence, transmission, and symptoms observed in plants need to be studied and analyzed. So, for these purposes, the review has highlighted the major and minor diseases occurring in pepper and resulting in yield loss and crop damage.

KEYWORDS

Piper nigrum | Foot rot disease | *Phytophthora capsici* | Anthracnose | *Colletotrichum piperis* | Leaf gall thrips | Red rot | Pollu beetle | *Longitarsus nigripennis* | *Elachertus*.

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Introduction

Spices form an essential part of human consumption since the rise of human race. As they have been continuously used from years to increase the quality of nutrition and also recognized for their preservative characteristics and medicinal properties (Catillo *et al.*, 2020). Piper species belongs to the Piperaceae family which is considered to be among the most ancient of flowering plants growing in tropical regions, comprising of 13 genera (Takooree *et al.*, 2019). This diversified genus Piper includes 4,166 scientific plant names of species rank; of these 1,457 are accepted species names, 1,376 synonyms, and 1,333 unassessed (Salehi *et al.*, 2019).

Piper nigrum L., also known as pepper, is considered to be the “king of spices” because of its huge importance and trade share in the global market. The name “pepper” originates from the Sanskrit word pippali, which means berry (Takooree *et al.*, 2019). *Piper nigrum* is a perennial woody aromatic climber that may grow to a height of 50–60 cm (Choi *et al.* 2020). According to Andriana *et al.*, (2019) *P. nigrum*, is native in Kerala in Southwestern India and widely distributed in tropical regions, including Indonesia. Its fruits are usually dried and used for spices and seasonings. This plant is used as a folk medicine to treat gastrointestinal disorder, rheumatic, flu, colds, muscular aches, and fever diseases. Biological activities of *P. nigrum* have been known as insecticidal, larvicidal, antioxidant, and antimicrobial activities. According to Salehi *et al.*, (2019) geographically, *P. nigrum* is mostly cultivated in hot and moist conditions. The primary areas of the black pepper cultivation are in the Western Ghats of the South Indian Peninsula, subsequently was introduced to other countries in South and Southeast Asia. *Piper nigrum* is mainly used as a culinary item in a wide variety of dishes. In Western cuisine, black pepper is principally used as a seasoning ingredient to enhance food flavor as well as in food

preservation. White and black peppers are different in their time of harvest and processing techniques. White pepper is obtained by removing the pulp from ripe fruit, while the black pepper is produced by drying unripe fruit until a wrinkled formed; therefore, black pepper contains the pulp. Both white and black pepper has a wide range of applications, like spices, preservatives, insecticides, and also in herbal medicine (Quijia and Chorilli, 2020). Ground white pepper is used in Thai and Chinese cuisine, in the preparation of salads, cream sauces, and light-colored sauces. Apart from its culinary uses, *P. nigrum* has immense importance in folk medicine in several countries. The phytochemistry analysis of this plant is widely studied by the scientific community, and a wealth of literature has emerged.

Crop loss

Black pepper cultivation in India has been under threat due to severe infestation and infection. According to Research and Market (2020), on a global scale, crop production has been estimated to be around 725K tonnes in 2020. About 25-35% vine death has been reported in Kerala. The disease has been spreading at an alarming rate all over the black pepper growing tracts during the last 15 years. Pathogens can attack all parts of the black pepper plant at any stage of crop growth (Sarma *et al.*, 1994). According to Anith *et al.*, (2003) none of the cultivated or wild varieties of black pepper show resistance to the disease. Plants when faced with unfavorable environmental conditions and parasitic microorganisms can cause disease. The plant disease-causing agents are mainly called pathogenic microorganisms (*i.e.*, viruses, bacteria, fungi, protozoa, nematodes) unfavorable environmental conditions (such as lack or excess of nutrients moisture and light) or even the presence of toxic chemicals in air or soil. Diseases in plants effect major production and economic losses as well as the reduction in both the quality and quantity of agricultural products. Nowadays, plant disease

detection has received increasing attention in monitoring a large field of crops. Farmers experience great difficulties in switching from one disease control policy to another. The naked eye observation of experts is the traditional approach adopted in practice for the detection and identification of plant disease. A symptom of plant disease is a visible effect of disease on the plant. Symptoms include a detectable change in color, shape, or function of the plant as it responds to the pathogen. Leaf wilting is a typical symptom of verticillium wilt, caused by the fungal plant pathogens *Verticillium albo-atrum* and *V. dahlia*. Common bacterial blight symptoms include brown, necrotic lesions surrounded by a bright yellow halo at the leaf margin or interior of the leaf on bean plants (Nyvall, 2013). We are not actually seeing the disease pathogen, but rather a symptom that is being caused by the pathogen. A sign of plant disease is physical evidence of the pathogen. According to Anandaraj *et al.*, (1991) bacterial canker of stone fruits causes gummosis, bacterial exudates emerging from the cankers. The thick, liquid exudate is primarily composed of bacteria and is a sign of the disease, although the canker itself is composed of plant tissue and is a symptom.

Pests and Pathogens: Limiting factors

Crop pathogens and pests reduce the yield and quality of agricultural production. They cause substantial economic losses and reduce food security at household, national and global levels. According to the studies the pepper plant faces serious leaf diseases. Plant diseases are divided into parasitic and non-parasitic microorganisms. The major plant pathogens are fungi, bacteria, viruses, and nematodes. Fungi are the common cause of plant diseases. According to Thornton and Wills (2015), more than 10,000 species of fungi are detected to cause diseases in plants. 50 species cause diseases in humans and many cause diseases in animals. Most plant diseases around 85% are caused by fungal or fungal-like organisms. The effect of fungi on plants can be

very terrible. It can destroy the cellular structure, formulate the physiological functions unstable and the rate of metabolic pathways are damaged by many factors that influence the sequences from the germ tube emergence to attachment, adhesion, aspersorium development, and the plant surfaces for the penetration to the plant (Azhar, 2013). Some fungi degrade the cell wall to enter the plant, other than that forming specialized structures i.e., appressoria to penetrate and enter the epidermis while others enter the host through natural opening even by thigmotropism or chemotropism (Lauren and Nicholas, 1996).

Another most common pathogens are algae. Algae are not normally considered as common pathogens. Plants so far reported to be infected by the endophytic alga *Cephaleuros* in India are less common. Infection occurs as dark-reddish or brown-greenish spots on the dorsal surface of leaves. The alga undergoes considerable variation under different conditions on the same host. Severe attacks of the alga occurred during the rainy season. The morphological variation of the alga is different. The genus *Cephaleuros* is a well-known parasitic or endophytic alga which at times causes serious damage to cultivated crops. A disease caused by this alga on tea plants is known as "Red Rust of Tea", and is a serious problem in plantations. This disease is more prevalent in north-eastern India, identified virescens as the causative agent, and said that *Cephaleuros* began to attract attention since 1880 as the cause of "white blight". The algae have a wide distribution in tropical and subtropical regions. In India, the occurrence of the alga as *Mycoidea* parasitic on tea plantations was observed from Assam and in 1897 the same algae as *virescens* Kunze. Since then many workers have reported its occurrence on various hosts. According to Freire, (1982) *virescens* as a causative agent of black fruit disease of pepper vines in Sarawak and listed all known plants infected by the alga in tropical plants of economic value.

Among the various pests which attack pepper, *Liothrips karnyi* is important as it deforms and damages the leaves by making marginal galls. Both the adults and larvae feed on the leaves and cause marginal folded galls. So far no chalcidoid parasitoids are known to attack this pest. According to Narendran and Bindu (2009), *Elachertus piperis* a new species of eulophid parasitoid (subfamily: Eulophinae) which has emerged from this thrip galls. It is quite likely that this parasitoid is a natural enemy of *L.karnyi* and may prove to be a useful biological control agent.

Diseases

According to M. Anadrai and Y. R Sharma on “Diseases of black pepper” it was found that although 17 diseases are recorded in black pepper (*Piper nigrum* L.). In the past four years, black pepper plants have been affected by new diseases other than root rot and stem blight (*Nectria haematococca* f. sp. *piperis*). The 4 major diseases are Phytophthora foot rot, blackberry disease, wrinkled leaf disease caused by a virus and root-knot disease caused by *Meloidogyne incognita* and *M. Javanica*.

Foot rot disease

Foot rot disease is caused by *Phytophthora capsici* which is a soil-borne fungus. *Phytophthora* foot rot causes high mortality of cuttings and severe economic losses. It infects all parts of the vine. The severity of the disease depends upon the plant part affected and the extent of damage and all the parts of the plant are susceptible to the fungus (Anadraj *et al.*, 1991) The disease has two important phases i.e., Aerial phase and soil phase.

Pathogen: *Phytophthora capsici* (*P. capsici*) is one of the most important vegetable pathogens worldwide (Fernandez *et al.*, 2004). It is an oomycete soil-borne plant pathogen that causes root, fruit, and foliar disease on a variety of vegetables. Plants that are infected by this pathogen will die within 2 - 3 weeks in rain and adjacent plants will be infected within one or two months. The quick death of *Piper nigrum* can be

presented that phytophthora spores develop into the roots and stems, especially collar causing foot rot. Rotting of collar destroys phloem and xylem, preventing the transfer of water and nutrient from the roots to aerial parts of the plant. Therefore, the plant died intermediately with symptoms of sudden leaf wilting and dropping.

Reproduction: Also, the reproduction process of the pathogen in several types, both sexual and asexual means. Meanwhile, mycelia produce three asexual spores including sporangia, zoospore, and chlamydospore. Zoospores are the major propagules of infection (Pérez-Jiménez, 2008). According to Hausbeck and Lamour (2004), each oospore that produces a male and female gametangium, so-called antheridium, and oogonium respectively serve as the overwintering inoculum of the pathogen. Moreover, under a good condition of free moisture on plant surface or saturated soil, sporangia release motile and biflagellate zoospores. Each sporangium produces 20 to 40 motile zoospores under free water conditions (Mchau and Coffey, 1995). Additionally, sporangia and zoospores are secondary inocula and they can be reproduced repeatedly during the growing season, causing a rapid escalation of disease (Nam, 2012). The life cycle of the pathogen is one of the elements that contribute to maintaining and developing pathogens. Temperature (20°C - 28°C) and moisture (>80%) are optimal for both chlamydospores and oospores live over 6 years in the soil; 2 - 3 rainy seasons in dead plant materials (Nambiar and Sarma, 1982). More importantly, inoculum can survive in the soil up to 19 months without host plants (Kueh, 1990).

Symptoms: The first symptoms of the disease are very hard and often undetected by farmers and technicians. They detected disease when the upper part of pepper vine shows performance as leaf yellowing, wilting, and dropping (Ton *et al.*, 2011). Once these symptoms are observed, the infection is already at its severe stage with most of the root rotted and the underground stem showing

a brownish-black lesion. Different phases of symptoms are aerial and soil phase:

Aerial phase: Appearance of dark brown lesions with fimbriate margins of leaves and rotting of aerial portions of stems and spikes resulting in varying degrees of defoliation and spike shedding causing the reduction in spike size.

Soil phase: According to Anandraj *et al.*, 1994 initially the infection goes unnoticed but later greater root loss and foliar yellowing are observed. The infection further spreads from feeder roots to thicker roots ultimately leading to the death of the vine. Although quick wilt is also called sudden death occurs when an infection is confined to collar or foot independently and feeder rots lead to a slow decline. According to Yellareddygari *et al.*, (2011) bacterial spot is caused by the bacterium *Xanthomonas campestris*. The pathogen invades pepper through wounded roots inflicted by nematodes (*Meloidogyne incognita* and *M. javanica*) are during the emergence of new roots. It colonizes the vascular bundles causing necrosis and preventing water and nutrients uptake. The vascular necrosis, unilateral initially, extends to the leaf veins of apical twigs resulting in quick wilt and death of plants. Externally, diseased plants show yellowing, shedding of leaves and internodes, and lack of rootlets. The internodes show triangular and necrotic lesions around the nodes of the main branch, which result in unilateral necrosis of the internode turn them half green half necrotic. When several roots are infected, the plant collapses getting the foliage adhered to the branches. If branches are cut, necrotic vessels of phloem can be seen immediately below epidermis.

Anthracnose

According to Kurien *et al.*, (2000) anthracnose is also called blackberry disease and is caused by *Colletotrichum capsici*, *C. piperis*, and *C. gloeosporioides*. Black pepper (*Piper nigrum* L.) is affected by various diseases in Kerala among

which anthracnose caused by *Colletotrichum gloeosporioides* (Penz) Penz & Sac. is gaining importance in recent years. The fungus causes damage to the plant both in the nursery and field. On older vines in the field, leaves, spikes, and berries are affected. Infection on spikes results in spike shedding, whereas, infection on immature berries leads to the formation of brownish splits on the berries. Spike shedding is more severe at high altitudes. The disease is seen throughout the crop season in plantations and maximum damage is caused from August to September and ranges from 28% to 34%. The damage to the berries due to *C. gloeosporioides* has also been reported to result in a 100% yield loss (Chethana *et al.*, 2000).

Pathogen: According to Shenoy *et al.*, (2007) *Colletotrichum capsici* is a fungal plant pathogen with a wide host range, including 121 host-genera in 45 plant families. The sexual ascomycete form is rarely found in nature. Conidiophores are 3-45 × 2-6 µm, hyaline, cylindrical, unicellular, or septate. Conidiogenous cells are 6-10 µm × 2.5-4 µm wide, hyaline, ellipsoidal to subglobose, conidia are 7-14 µm × 2.5-3.5 µm, one-celled, gluttulate, hyaline, fusiform with both ends pointed. *Colletotrichum capsici* is an air-borne, seed-borne, and also soil-borne pathogen. It can survive in moist soil and plant debris for several years. The fungus can spread by rain splash and irrigation water. It can also spread by infected soil, farm tools, and shoes.

Symptoms: According to Than *et al.*, (2007) anthracnose can cause extensive pre- and post-harvest damage, as well as pre-harvest symptoms on leaves and stems. Often, symptoms of the post-harvest disease do not develop until the fruit is ripe. Typical symptoms are circular or angular sunken lesions on fruits, with concentric rings of acervuli. Orange conidial masses are often produced in acervuli creating a surface that is wet and slimy. Lesions may coalesce under severe disease pressure. The fungus can be carried by seeds intraembryonally. Enzymes produced by *C. capsici* can disrupt seed tissues. Conidial masses

generated from the acervuli can serve as a primary inoculum source. The fungus can spread from the seed to the placenta of the fruit, then penetrate the developing ovules or young seed. The infection of seeds can also occur directly from the mother plant. Conidia can remain dormant on the surface of the testa until seed germination (Lewis *et al.*, 2004).

Leaf gall thrips

Leaf gall Thrips (*Liothrips karnyi* Bagn.) damage has a huge effect on the demand for pepper planting materials under nursery conditions. Leaf gall thrips are caused by *Liothrips karnyi* which is important as it deforms and damages the leaves by making marginal galls. Both the adults and larvae feed on the leaves and cause marginal folded galls. So far no chalcidoid parasitoids are known to attack this pest.

Pathogen: *Liothrips Karnyi* belongs to insect Thrips which live in colonies within tubular marginal galls induced by them. The thrips are <3 mm in length and black. Eggs are laid within the marginal galls on the leaf surface singly. Emerging thrips pass through first and second nymphal, prepupal and pupal instars and become adults in 13-18 days. All stages of thrips are seen in the marginal galls.

Symptoms: Margins of infested leaves are folded and thrips feed on inside these marginal galls. Eggs and other immature stages can be seen inside the galls. Severe damage results in yellowing and shedding of leaves. Downward and inward curling of leaves resulted in the formation of marginal leaf galls. Later the infected leaves become crinkled and malformed. In severe cases of attack, the whole plant may become stunted, affecting adversely the formation of spikes.

Red rot or blackberry disease

Cephaleuros virescens are the causative agent of red rot or blackberry disease. Species are filamentous green algae and parasites of higher plants. The disease is called algal leaf spot, algal fruit spot, and green scarf; *Cephaleuros* infections

on tea and coffee plants have been called “red rust.” These are aerophilic, filamentous green algae but still require a film of water to complete their life cycles.

Pathogen: The genus *Cephaleuros* is a member of the Trentepohliales and a unique order, Chlorophyta, which contains the photosynthetic organisms known as green algae. *Cephaleuros* species consist of branched filaments that comprise a thallus in the form of irregular discs. The thallus grows below the cuticle or sometimes below the epidermis of the host plant. This pigmented thallus (orange to red-brown) consists of a prostrate portion that is branched irregularly with irregular cells and an erect portion of unbranched hairs, with cylindrical cells, sterile or fertile, protruding through the cuticle. Haustorial cells are sometimes present inside the plant host’s tissue.

Reproduction: Sporangiohores bear one or more head cells subtending sporangiate-laterals. Gametangia are terminal or intercalary on the prostrate cell filaments. *Cephaleuros* species are capable of both asexual and sexual reproduction. Through sexual reproduction, the resulting zygote produces a dwarf sporophyte. The life history consists of an alternation of heteromorphic generations, with the sporophyte reduced to a dwarf plant. The asexual stage is probably much more important to the typical infection and disease processes. These pathogens are dispersed by wind and splashing water.

Symptoms: Symptoms and crop damage can vary greatly depending on the combination of *Cephaleuros* species, hosts, and environments. *C. virescens* is a subcuticular parasite, while *C. parasiticus* is an intercellular parasite. Spots caused by *C. parasiticus* on guava leaves are a top-down, intercellular, full-thickness necrosis, destroying both upper and lower epidermal cell layers and all intervening tissues. Then, a bright but relatively sparse orange algal bloom bursts forth from the undersides of leaf lesions, rather

than from the upper side of leaves as is usually the case with *C. virescens*, the more commonly occurring species in the genus. The distinctive and much more common spots caused by *C. virescens* on many hosts in Hawaii appear on the upper leaf surface as raised yet flattened, textured, burnt-orange to brown or rust-colored, circular areas up to about 2 cm in diameter, having indistinct, filamentous margins and fuzzy surface topographies. Yet, this species is generally a relatively harmless, subcuticular leaf parasite. On leaves, symptoms vary according to the Cephaleuros-host species combination. For *C. virescens*, leaf spots are usually on the upper leaf surface, raised, velvety in appearance, in shades of orange or brown.

Minor disease

Minor diseases include erythrina gall wasp, blight, basal wilt, etc. Hence diseases are the interactions of a host plant and various organisms (Zhou and Hyde, 2001). Even minor diseases have caused losses of production under special climate conditions. Descriptions of the pathogens and main symptoms are given.

Pollu beetle

Pollu beetle is the most important and a specific pest of Pepper. The adult is a small shiny blue beetle about 2.5 mm in length. Its hind legs are stout and modified for jumping long distances. On receipt of pre-monsoon showers, pepper plants start putting forth new flushes. Then the residual population growing in shaded areas becomes active. Beetle spends its life cycle on new flushes feeding on tender leaves and boring into tender shoots till the plant puts forth spikes. Once the spike appears the beetle moves to the spike. Berries are attacked when they start appearing.

Pathogen: *Longitarsus nigripennis* (Chrysomelidae: Coleoptera)

The adult is a bluish yellow shining flea beetle. Eggs are laid on the berries and lays 1-2 eggs in each hole, egg period 5-8 days, larval period 30-32 days. Pupation occurs in the soil in a depth of

5.0 - 7.5 cm. Pupal period 6-7 days. The life cycle was completed in 40 - 50 days. Four overlapping generations in a year.

Symptoms: The pollu beetle is a serious disease in black pepper plantations in the plains and at lower altitudes. The grubs bore into the berries of pepper. The infested berries dry up and turn dark in color. Berries are hollow and crumble when pressed. Such hollow berries are called "POLLU" (Empty). Grub may also eat the spike causing the entire region beyond it to dry up. When contents of one berry are exhausted, the grub moves to next and feed continuously. With the appearance of new flushes, beetle lays eggs on them. Emerging grubs bore in to tender shoots and as a result, the tender shoots dry. Beetle also lays eggs on tender leaves, the emerging grubs scrape, and feed on leaves.

Portions of leaves subjected to attack by the grub later dries and are blown away by wind and result in the formation of holes on leaves. Beetle also feeds on leaves resulting in feeding holes. When spikes are formed the beetle lays eggs on the spike. The emerging grubs bore into the spike and the spike beyond the area of damage breaks resulting in "murithiri"(broken spike). When the spike develops and becomes hard the grub feed on the skin of the spike. Damage to spike affects the berry formation badly. When the berries are formed the beetle makes small holes on the berries and lays an egg. Attacked berries become hollow and crumble when pressed. Such hollow berries are called pollu berries.

Erythrina gall wasp

Erythrina stricta Roxb., a quick-growing species with showy red flowers, is grown as a *Quadrastichus erythrina* – female wasp. the standard for trailing black pepper (*Piper nigrum* L.) and vanilla (*Vanilla planifolia* Andr.) throughout south India. Severe incidence of *Q. erythrina* has been noticed on *E. stricta* in the plains of Thiruvananthapuram District, Kerala

since April 2005 on a serious proportion. Interestingly, during the same period, the pest was also reported from Hawaii infesting three different species of *Erythrina*. Similarly, a five-centimeter long piece of galled petiole and tender stem produced up to 51 and 64 wasps respectively. The sex ratio of wasps emerging from galls was highly skewed towards males, with 2.7 males emerging for each female. Severely infected branches appear stunted and bushy. Galled leaves and tender branches finally dry up. As the newly emerging leaves are converted into galls, there is a severe reduction in the number and size of leaves besides complete cessation of growth. Such trees present a scrawny appearance with the malformed and crinkled shoot.

Pathogen: *Quadrastichus erythrina* Kim, (Hymenoptera: Eulophidae)

According to Kaufman *et al.*, (2020) invasive *Erythrina* Gall wasp (EGW), was first reported from the Mascarene Islands and Singapore in 2003. It was subsequently reported from Tawain, India, American Samoa, China, Thailand, Malaysia, Guam, Philippines, Vietnam, Japan, Hawaii, Mariana Islands, Barbados, Brazil, and Florida, and most recently Central America, within a remarkably short time of the initial detection of the invasion. The worldwide invasion by *Q. erythrina* appears to have originated from a single source in East Africa and is characterized by low genetic diversity.

Reproduction: Female EGW lay eggs inside new leaves, petioles, stems, flowers, and young seedpods of *Erythrina* plants. Multiple generations of EGW may be produced each year. It is unclear how the gall wasps survive the period when *Erythrina* trees drop their leaves, but it is assumed they enter a quiescent state within fallen leaves. Larval feeding induces deformation and swelling of young tissues. Larvae pupate inside the galls and adults emerge from the galls by tunneling through the infested material to the outside (Kaufman *et al.*, 2020). A heavy

infestation can cause severe defoliation and therefore deterioration of plant health that may lead to plant death.

Symptoms: According to Shylesha *et al.*, (2012) the nature of damage observed on *E. stricta* was similar to those described by Yang *et al.*, 2004. Female wasp thrusts eggs into tender tissues of shoots using the exerted ovipositor. Apodous, creamy white larvae develop individually in chambers formed inside the meristematic tissue. The proliferation of tissues in the attacked portion results in gall formation. Galls are formed on the entire developing stem, petiole and leaf lamina with characteristic enlargement and malformation. The mean thickness of galled petioles was 3.1 times more than that of normal. In the case of the tender stem, infestation resulted in the enhancement of mean thickness twice. Multiple galls with layers of larval chambers are formed in the affected portion. Infected leaves fail to attain the normal size and shrivel with thick galls on them. Petioles and tender stem enlarge in thickness and present a curly appearance with knot-like galls on them.

Slow decline

Burrowing nematode disease; toppling disease, blackhead disease (banana); spreading decline (citrus); yellows, slow wilt (black pepper).

Pathogen: *Radopholus similis* (Nematoda, Tylenchida, Pratylenchidae)

It was first observed by Nathan A. Cobb in necrotic banana roots from Fiji in 1891. The signs of these diseases are the various stages of *R. similis* observed in soil and plant root samples. All nematode stages are vermiform (wormlike), colorless, and less than 1 mm in length. Adult males and females are different in appearance (sexual dimorphism), the males having poorly developed stylets and a knob-like head caused by an elevated, constricted lip region. Both males and females have long, tapered tails with rounded or indented ends. The male has a sharp, curved spicule (male reproductive organ), enclosed in a

bursa, or sac. Females are between 550 and 880 μm (0.55 to 0.88 mm) in length and about 24 μm in diameter, with well-developed stylets 16 to 21 μm (average 18 μm) long. Males are smaller than females, 500 to 600 μm in length. Juveniles are often present in both root and soil samples and average between 315 to 400 μm in length with stylets 13 to 14 μm long.

Reproduction: Over 350 plant hosts in tropical and subtropical regions including banana, citrus, black pepper, aroids (anthurium, philodendron, taro), ginger, tea, coconut, and other tropical palms. The burrowing nematode is an obligate parasite and needs a living host to survive, though its various stages can move from root to soil and vice versa. It is classified as a migratory endoparasite, completing its life cycle as it tunnels through the root cortex. Females and juvenile stages are infective but males with their weak stylets do not feed. *Radopholus similis* usually penetrate roots near the tip but can invade along the entire length of the root. They move between cells of the root cortex, feeding on them until the cells collapse and form necrotic passages. In most hosts, *R. similis* does not damage the central cylinder, though the citrus race reportedly feeds on the phloem, girdling and destroying the stele. Migration and egg-laying are stimulated by nutritional factors: females need healthy tissue to feed on, but eggs are laid in root tissue that quickly decomposes. Females usually reproduce sexually, but can also reproduce without males. This phenomenon was once considered parthenogenesis, but recent studies suggest it might be hermaphroditism. Females lay 4 to 5 eggs per day (2 per day in citrus) for several weeks as they move through the root cortex.

Symptoms: Most soil-borne plant pests and diseases are not evident above ground until they are well established. Early symptoms caused by root-feeding pests are due to impaired water and nutrient uptake. These symptoms include stunted plant growth, decreased vigor and yield, premature leaf drop, and an increased tendency to

wilt or dieback during dry periods. *Radopholus similis* causes a slow decline of many plant species, but symptoms are distinctive in banana and plantain (*Musa* hybrids and cultivars.), citrus (*Citrus* spp.), and black pepper (*Piper nigrum*).

The main symptoms of yellows, or slow wilt disease of black pepper, are pale yellow leaves that droop and then fall from the vine. Other symptoms caused by decreased water and nutrient uptake are slow plant growth, flower drop, and vine dieback. Symptoms are more pronounced during dry periods, but if moisture becomes available early in the disease (e.g. tropical monsoon rains) leaves are replaced and vines appear to recover. In 3 to 5 years, however, the disease will re-emerge, and so the name 'slow wilt'. Burrowing nematode attacks both young and old plants, so vines replanted in infested soil normally die within 2 years. Thin, white feeder roots have purplish lesions and are quickly destroyed. Lesions are harder to see on older, brown roots, which are slower to rot.

Yellow Mottle virus disease

Piper yellow mottle virus (PYMoV) (genus: Badnavirus) is an important virus infecting black pepper and related species in India and other parts of the World (Bhat *et al.*, 2003). Mottle disease caused by viruses is one of the black pepper main diseases and has been recorded in several countries i.e. India, Thailand, Malaysia, Sri Lanka, Brazil, Philippines, and China. This disease is associated with the Piper yellow mottle virus (PYMoV) (Badnavirus: Caulimoviridae) and Cucumber mosaic virus (CMV) (Cucumovirus: Bromoviridae) (Revathy and Bhat, 2017). Both viruses have also been detected on black pepper plantations in Indonesia. The incidence of the disease reached 95% in Bangka and Lampung in 2005 (Lakani, 2006). According to Alif *et al.*, (2018), the high incidence of this disease was also observed in Yogyakarta (86 – 93.75%) PYMV and possibly other unidentified viruses have been one of several factors in a

disease complex limiting black pepper production and contributing to black pepper plantation decline in southeast Asia. There have also been reports of a viruslike disorder of black pepper in India and symptoms similar to those described above for PYMV infection were observed previously in India and Indonesia. This suggests that PYMV may occur in black pepper in Southeast Asian countries other than those mentioned above. Black pepper is a perennial vine propagated vegetatively through stem cuttings that favor the build-up of virus concentration over time and the virus moves from one place to another through vegetative propagules. Also, PYMoV is transmitted through seeds.

Pathogen: Badnavirus: Caulimoviridae

The virus, named Piper yellow mottle virus (PYMV), had non-enveloped bacilliform virions averaging 30 x 125 nm in size and containing a double-stranded DNA genome. Piper yellow mottle virus resembles the majority of badnaviruses in having a restricted host range but differs from other badnaviruses in the unusual configuration of a large proportion of its genomic DNA molecules observed by EM and a relative resistance of its extracted genomic DNA to S1 nuclease digestion. The rod-like configuration and resistance to S1 nuclease of some PYMV DNA molecules suggest that these may represent covalently closed, supercoiled molecules.

Symptoms: The affected plant show a diverse range of symptoms such as mosaic, interveinal chlorotic mottle, chlorotic specks, vein clearing, yellow mottling, leaf size reduction and deformation, reduction in internode length, stunting of plants, reduced plant vigor and poor fruit set (Bhat *et al.*, 2003).

Ecological Management

The key to sustainable plant disease management is to establish an agro-ecological system that is favorable to plant growth and development at the population level and adverse to pathogen evolution and epidemic development based on

interactions among plants, pathogens, vectors and environments (Acosta-Leal *et al.* 2011). This management system includes two main components: multiple goals (high yield, efficiency, good quality, and safety) and dynamic and integrated approaches guided by a comprehensive understanding of the evolutionary ecology of particular host-pathogen interactions. This integrated approach shows great promise in overcoming the problems and challenges associated with current strategies of plant disease management to optimize its economic, ecological, and social benefits.

Prevention Measures

Spraying pesticides to kill pathogens and/or their insect vectors is an inseparable part of plant disease management when other approaches cannot achieve the required level of pathogen population density reduction and epidemic amelioration. However, the use of pesticides in an integrated disease management system is not to eradicate the disease but to control it to the most appropriate extent as guided by ecological and economical thresholds. During pesticide application, factors such as action modes and pathogen resistance should be considered. To increase their efficiency of application and reduce negative impacts on the environment, pesticides should be used in combination with disease forecasts and knowledge of the pathogen population genetic structure (Zhan *et al.* 2015) to determine the best time and frequency of application and to choose the type and utilization dosage of the pesticides. Remedy successes could also be achieved by other approaches than synthetic fungicides such as naturally occurring plant compounds with biological control activity—for example protein $\gamma 3$ that is extracted from edible fungi and other microbes (*Bacillus* spp.) (Kumar *et al.* 2014). To ensure effective use of such bio-pesticides a better understanding of their properties and application procedure is important as is information about relevant biological features and the transmission mode of pathogens.

For example, adding viral therapeutic agents or biological control agents in 1–2 sprays at the rice seedling and turning green stage can not only reduce viruliferous insect population density but also protect the plant from further infection (Xie *et al.* 1979). Combining pesticides with other biotic and abiotic approaches such as biological agents, soil pH adjustment and UV irradiation has proved to be very effective in long-term control of tomato and lettuce root rot (Lee 2015). Cultural practices including phytosanitation and repeated prophylactic application of copper fungicides are the recommended measures for the management of this disease. Biological control has emerged as an important alternative in managing soil-borne plant diseases in recent years. *Pseudomonas* spp. have been used extensively as biological control agents against many soil-borne plant pathogens in several crops. Although the integrated soilborne disease management strategies may not eradicate all the pathogenic organisms from the soil, it entails continuous exploration and research for sustainable crop production which will secure a sustainable future for an ever-growing population (Milan *et al.*, 2020).

Conclusion

Pepper (*Piper nigrum* Linn.) (Piperaceae), known as the king of spices is indigenous to India. Here, we have reviewed several major and minor diseases, pests and pathogens, and the symptoms that lead to crop damage and yield loss. These diseases include fungi, algae, viruses, and insects which affect both leaves as well as roots. The diseases are responsible for major yield losses in commercially important crops worldwide. In addition to evaluating the agricultural significance of diseases, it is necessary to develop management and prevention measures that inhibit the growth of pathogens as well as enable the rapid growth of the plant.

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Compliance with Ethical Standards

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Conflict of Interest

Both authors declare that they have no conflict of interest.

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Amending *Strobilanthes gamblei* (Acanthaceae) and an overlooked new species *Strobilanthes bourdillonii* from the Western Ghats, India

PRADEEP ANNAVIVEETIL KRISHNAPILLAI^{1,5}, SINJUMOL THOMAS^{2,6}, SUSAI JOHN BRITTO^{3,7} & BINCE MANI^{4,8*}

¹ WWI Innovative Solutions, Kottayam-686576, Kerala, India.

² Department of Botany, Carmel College, Mala, Thrissur-680732, India.

³ The Rapinat Herbarium and Centre for Molecular Systematics, St. Joseph's College (Autonomous), Tiruchirappalli-620002, India.

⁴ Department of Botany, St. Thomas College Palai, Kottayam-686574, India.

⁵ wildworldindia.in@gmail.com; <https://orcid.org/0000-0002-7754-8598>

⁶ sunithatom@gmail.com; <https://orcid.org/0000-0003-4907-9197>

⁷ sjohnbritto@hotmail.com; <https://orcid.org/0000-0002-0501-4271>

⁸ binsnm@gmail.com; <https://orcid.org/0000-0002-6076-4622>

*Corresponding author: binsnm@gmail.com

Abstract

Strobilanthes lawsonii was described by Gamble based on four gatherings collected from different parts of the Western Ghats. However, the gatherings cited in the protologue represent three different species. Carine *et al.* identified them to be *S. lawsonii*, *S. gamblei* and *S. pushpangadanii*. However, the specimen identified as *S. pushpangadanii* and many specimens collected from various parts of Kerala and Karnataka as *S. gamblei* by them represent a new species, *S. bourdillonii*. An updated description is provided for *Strobilanthes gamblei*.

Keywords: Acanthaceae, Kerala, *Strobilanthes pushpangadanii*, *Strobilanthes lawsonii*

Introduction

Strobilanthes Blume (1826: 781) is the second largest genus in the family Acanthaceae confined to the south and southeast of Asia and Melanesia (Carine & Scotland 1998, Carine & Scotland 2002) and comprises about 450 species (Mabberley 2017). The genus is represented by more than 150 species in India (Karthikeyan *et al.* 2009, Thomas *et al.* 2020a), of which approximately 70 species occur in south India alone (Carine & Scotland 2002, Venu 2006, Thomas *et al.* 2020a, 2020b). Species delimitation remains problematic in *Strobilanthes*, since many species are inadequately known and seldom disparagingly collected due to their plietesial flowering pattern and narrow distribution (Wood & Scotland 2009, Chen *et al.* 2019, Fernandes & Krishnan 2019, Thomas *et al.* 2019a, Thomas *et al.* 2019b). A comprehensive and critical study of *Strobilanthes* groups hence pose a big challenge to taxonomists. It is possible therefore to recognize clearly diagnosable species groups within this genus (Carine *et al.* 2004). *Strobilanthes kunthiana* group is a such group which is characterized by spicate inflorescences, 5-partite calyces, two fertile stamens and densely hygroscopic-pubescent seeds (Carine *et al.* 2004). *Strobilanthes lawsonii* Gamble (1923: 374) is one of the complex taxon in this group. When it was described, Gamble (1923) cited four gatherings, viz., two from the Sispara Ghats, Nilgiris (*Lawson & Gamble 13387* and *Gamble 14252*), one from Tambracheri Ghat, Wynaad (*Barber 5686*) and the fourth from Travancore Hills (*Bourdillon 42*). Recent studies revealed that the material cited by Gamble (1923) consists of more than one species. Carine *et al.* (2004) published a new species, *Strobilanthes gamblei* Carine *et al.* (2004: 5) for *Barber 5686*, and treated *Bourdillon 42* as *S. pushpangadanii* E.S.S. Kumar *et al.* (2002: 73). Therefore, *S. lawsonii* maintained for the remaining two gatherings and designated *Lawson & Gamble 13387* as the lectotype for the name. However, after examined all original material, it is concluded that *Bourdillon 42* is a distinct species from *S. pushpangadanii*.

Strobilanthes lawsonii is characterized by its regularly lobed corolla (nearly campanulate) and included stamens. In contrast, *S. gamblei*, *S. pushpangadanii* and the gathering treated as *S. pushpangadanii* (*Bourdillon 42*) have bi-

lipped and hooded corollas and exerted stamens (Carine *et al.* 2004). A detailed analysis of the above materials, along with materials in various herbaria and live materials distinctly indicate that the gathering *Bourdillon 42* differs from *S. gamblei* and *S. pushpangadanii* by its leaf blade ovate with long petiole, interrupted spikes, bract acuminate at apex and corolla lobes narrowly triangular. This implies that it does not match any known species, and represents a new species described below as *S. bourdillonii*. *Strobilanthes gamblei* and *S. pushpangadanii* have narrow distribution, whereas *S. bourdillonii* has a wider distribution in the western parts of the Western Ghats especially in the states of Kerala and Karnataka. Carine *et al.* (2004) treated the specimens collected from various parts of the Western Ghats as *S. gamblei*. This treatment and the use of heterogeneous materials for describing *S. lawsonii* (Gamble 1923) would lead to misidentify the specimens collected from the state of Kerala and Karnataka as either *S. gamblei* or *S. lawsonii* (Sasidharan & Sivarajan 1996, Venu 2006, Augustine 2018). However, it differs from *S. gamblei* (Barber 5686), but it is well identical with *S. bourdillonii*. The live materials collected from the type locality are strongly helpful to solve the problems pertaining to the species mentioned above.

Taxonomy

Strobilanthes bourdillonii A.K. Pradeep, Sinj. Thomas, B. Mani & Britto, *sp. nov.* (Fig. 1 & 2)

The new species is allied to *S. pushpangadanii*, but differs by its leaves long petiolate with entire margin (not shortly petiolate with denticulate margin), spikes 8–12 cm long and interrupted (not 3–6.5 cm long and uninterrupted), bract acuminate (not acute) at apex, bracts unequal (not equal) to calyx and corolla lobes narrowly triangular (not ovate).

Type:—INDIA. Kerala: Idukki district, Peermed, *Bourdillon 42* (holotype MH!).

Description:—Erect isophyllous shrubs, up to 2.5 m high; stem angled when young, then terete, profusely branched, tawny tomentose. Leaves opposite, symmetrical; petiole 4.0–10.0 cm long, tomentose; blades ovate to elliptic, 9.0–17.0 × 6.5–10.0 cm, coriaceous, base rounded or obtuse, decurrent onto the petioles, margin entire, apex acuminate, tawny or cream indumentum abaxially, puberulent adaxially, lateral nerves 6–13 pairs, prominent on both surfaces, raised beneath. Spikes axillary or terminal, interrupted, 8.0–12.0 cm long, 2–3 mm broad, tawny hairy at anthesis; peduncle quadrangular; bracts ovate, 7–10 × 2.5–3.5 mm, shorter than calyx at anthesis, tawny hairy abaxially, glabrous adaxially, apex acuminate; bracteoles 6–8 × 0.5–1 mm, lanceolate, trichomes same as bracts. Calyx 8–11.5 mm long, 5-lobed, tube 2–4 mm long, lobes 6–7.5 × ca. 1.0 mm, lanceolate, unequal with two lobes shorter than others, tawny hairy abaxially, pubescent adaxially, apex acuminate. Corolla pink, 2.5–3.6 cm long, ventricose; tube 4–7 mm long, glabrous; throat 1.2–2 cm long, fine pubescent outside, long white hairy inside; limb 5-lobed; lobes unequal, 7–9 × ca. 3 mm, narrowly triangular, fine pubescent outside, glabrous inside, two adaxial lobes partly fused to form a hood. Stamens 2, exerted, basally attached to corolla tube; filaments 1.2–2.4 cm long, villous at base; anthers ca. 3 × 1 mm, oblong, thecae two, held perpendicular to filament. Ovary ca. 2 × 1 mm, glabrous, 2-locular, 2 ovules per locule; style 1.5–2.5 cm long, filiform, pubescent up to middle; stigma simple, slightly curved, ca. 2 mm long, glabrous. Capsule oblanceolate, 13–15 × ca. 4 mm, glabrous. Seeds 2, widely ovate, ca. 2.5 × 2.5 mm, with thick appressed hairs.

Etymology:—The new species is in honour of the collector, Thomas Fulton Bourdillon (1849–1930), who was the conservator of forests of the former princely state of Travancore during 1891–1908 and large collections of Travancore plants are to his credit including *Strobilanthes*.

Phenology:—Flowering from October to December; fruiting from January to May.

Habitat and distribution:—This species grows on wet and dripping rocks and streams in evergreen forests and grasslands at an elevation above 600 m along the western sides of Western Ghats in the Kerala and Karnataka states.

IUCN conservation status:—According to the current estimates this species could be treated as near threatened (NT). However, if the habitat destruction and its loss continues in the present pace, then the taxon likely to qualify for a threatened category in the near future (IUCN Standards and Petitions Committee 2019).

Additional specimens examined (paratypes):—INDIA. Kerala: Kannur District, way to Chandanathode, 27 February 1979, *Ramachandran 133374* (MH); Palghat District, karapara River, 900 m, 29 October 1976, *Vajravelu 48748* (MH); Thrissur District, Sholayar, 950 m, 29 September 2016, *Bince 68218* (RHT), Idukki District, Calvery Mount, 14 October 1982, *Mohanan 74683* (MH); Kakki dam area, 1000 m, 10 October 1983, *Pandurangan 152158* (MH); Vagamon, ± 1000 m, 8 November 1984, *Kadavil 953* (MH); same locality, 800 m, 08 October 2016, *Bince 68186* (RHT); same locality, 1170 m, 18 December 2016, *Pradeep 68248* (RHT); Peermedu, 780 m, 25 December 2015, *Pradeep 68243* (RHT); Pullikkanam, 850 m a.s.l., 28 August 2016, *Bince 68211* (RHT).

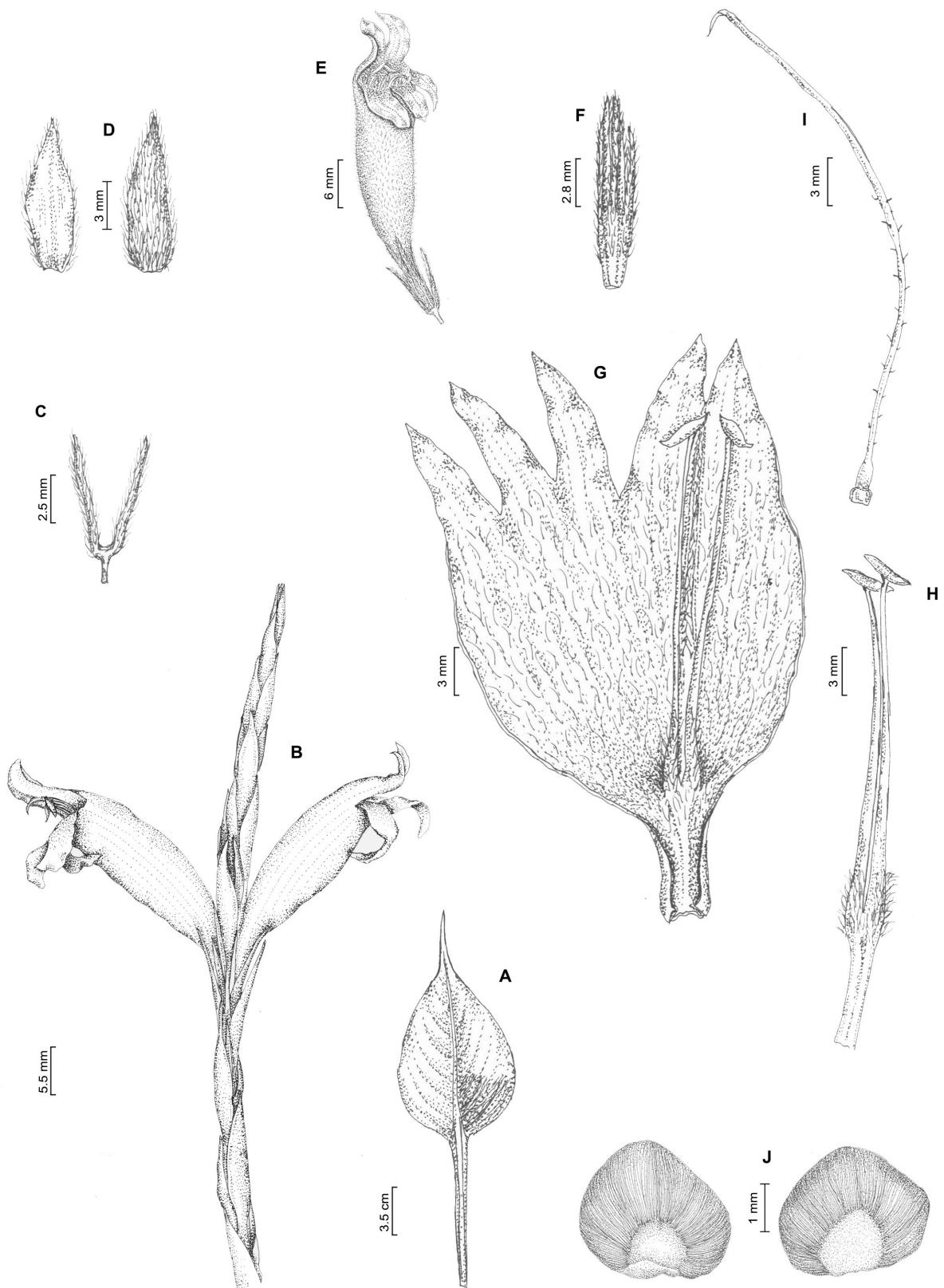


FIGURE 1. *Strobilanthes bourdillonii* sp. nov. A. Leaf; B. Inflorescence; C. Bracts; D. Bracteoles; E. Flower; F. Calyx; G. Corolla section; H. Stamen; I. Pistil; J. Seeds. Illustrated by Philominal Selvi.



FIGURE 2. *Strobilanthes bourdillonii* sp. nov. A. Habit; B. Leaf; C. Flowering twig; D. Inflorescences; E. Bracts; F. Bracteoles; G. Calyx; H. Corolla; I. Corolla split open showing the exerted stamens and anthers held perpendicular with the filament dorsifixed; J. Pistil; K. Seeds.

Strobilanthes gamblei Carine *et al.* (2004: 5) (Fig. 3)

Type:—INDIA. Kerala: Kozhikode District, Tambracheri Ghat, Wynaad, 21 January 1903, *Barber 5686* (holotype K!; isotype MH!).

Strobilanthes gamblei can be easily distinguished from *S. bourdillonii* and *S. pushpangadanii* by its leaves with long acuminate apex, presence of white indumentums on leaves and inflorescences, glandular hairy inflorescence at anthesis, bracts with abruptly acuminate apex, anthers held parallel to the filament (adnate) and glandular pubescent ovary apex and glabrous style.

Description:—Erect isophyllous shrubs, up to 1.8 m high, semelparous; stem angled (young) to terete (mature), greenish purple, profusely branched, densely white sericeous. Leaves opposite, slightly asymmetrical; petiole 0.8–4.7 cm long, tomentulose; lamina lanceolate to lance-ovate, 4.5–13.3 × 1.2–6.6 cm, chartaceous, rugose, base narrowly cuneate to cuneate, apex long acuminate, margin entire, dense white sericeous indumentum on abaxial surface, glabrous on adaxial surface except mid-vein; lateral nerves 3–9 pairs, prominent on both surfaces, raised beneath. Spikes axillary or terminal, uninterrupted, 5.5–11.0 cm long, 2.5–3.5 mm broad, glandular hairy at anthesis; peduncle quadrangular, covered with white indumentum; bracts lance-ovate, 4.5–6 × 2–2.5 mm, shorter than calyx at anthesis, entire at margin, apex caudate, abaxially glandular-hairy and white woolly indumentum at anthesis, adaxially pubescent; bracteoles 3.5–4.5 × 0.5 mm, linear-lanceolate, pubescence same as bracts, axillary secondary flower buds present. Calyx 6–7.5 mm long, tubular, 5-lobed, tube 2.5–3.5 mm, lobes 3–4.5 × 0.5–1.0 mm, linear-lanceolate, apex acute, unequal with two lobes shorter than others, dense white sericeous indumentum mixed with glandular hairs abaxially at anthesis, pubescent adaxially. Corolla blue, 1.9–2.2 cm long, ventricose; tube 3–5 mm long, glabrous; throat 1.0–1.4 cm long, fine pubescent outside, long white hairy inside; limb 5-lobed, lobes unequal, two adaxial lobes partly fused, 4–5 × ca. 3 mm, oblong, apex shortly cuspidate, fine pubescent outside, glabrous inside. Stamens 2, exerted, basally attached to corolla tube; filaments 8–9 mm long, villous below for ¼; anthers bithecous, thecae oblong, ca. 2.5 × 1 mm. Ovary ca. 1.0 × 0.5 mm, glandular-pubescent towards tip, 2-locular, 2 ovules per locule; style 1.5–1.6 cm long, filiform, glabrous; stigma simple, slightly curved, linear, ca. 2 mm long, glabrous. Capsule unseen.

Phenology:—Flowering from October to December; fruiting from March to May.

Habitat and distribution:—It grows on open rocks in evergreen forests and along the banks of stream and known from Kozhikode District in Kerala at an elevation of 400–650 m.

IUCN Conservation status:—This enigmatic species is probably a narrow endemic distributed in and around the type locality only. Based on the current estimates and IUCN criteria it is placed in the endangered [B1B2ab(iii)CC2a(i)] category (IUCN Standards and Petitions Committee 2019).

Additional specimens examined:—INDIA. Kerala: Kozhikode District, Thamarassery Ghat, 450 m, 20 November 2013, *Pradeep A.K. et al. 68238* (RHT); Thamarassery Ghat, 480 m, 28 January 2014, *Pradeep A.K. et al. 68239* (RHT).

TABLE 1: Comparison of diagnostic characters among *Strobilanthes gamblei*, *S. bourdillonii* and *S. pushpangadanii*.

Characters	<i>S. gamblei</i>	<i>S. bourdillonii</i>	<i>S. pushpangadanii</i>
Leaf shape	Lanceolate to lance-ovate	Often Ovate, rarely elliptic	Elliptic
Leaf base	Cuneate	Rounded/obtuse	Cuneate
Leaf apex	Long acuminate	Acuminate	Acuminate to cuspidate
Leaf margin	Entire	Entire	Denticulate
Leaf veins	3–9 pairs	6–13 pairs	8–13 pairs
Lamina texture	Chartaceous	Coriaceous	Coriaceous
Abaxial leaf indumentum	Dense white woolly	Dense cream or tawny woolly	Tawny woolly
Petiole	0.8–4.7 cm long	4.0–10.0 cm long	0.5–2.0 cm long
Inflorescence	5.5–11.0 cm long, uninterrupted spikes, glandular hairy at anthesis	8.0–12.0 cm long, interrupted spikes	3.0–6.5 cm long, uninterrupted spikes
Axis pubescence at anthesis	White indumentums	Cream or tawny indumentum	Tawny woolly
Bract shape	Lance-ovate	Ovate	Ovate
Bract apex	Caudate	Acuminate	Acute
Adaxial bract pubescence	Pubescent	Glabrous	Glabrous
Bract:calyx ratio	Shorter	Shorter	± equal
Corolla lobes shape	Oblong	Narrowly triangular	Ovate
Attachment of anther to filament	Adnate, held parallel	Dorsifixed, held perpendicular	Dorsifixed, held perpendicular
Pubescence on ovary apex	Glandular pubescent	Glabrous	Glabrous



FIGURE 3. *Strobilanthes gamblei*. A. Habit; B. Flowering twig showing white indumentum on stem, abaxial leaf surface and inflorescence; C. Inflorescence; D. Bract: abaxial and adaxial surface; E. Bracteole and calyx; F. Flower: latero-abaxial view; G. Corolla split open showing the exerted stamens and anthers held parallel with the filament adnate; H. Pistil.

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RESEARCH ARTICLE

Variation in antioxidant activity at two ripening stages of wild mango, *Spondias pinnata* (L.f.) Kurz., an underutilized fruit

Bince Mani¹ & Sinjumol Thomas^{2*}

¹Department of Botany, St. Thomas College, Palai, Kottayam 686 574, India

²Department of Botany, Carmel College, Mala, Thrissur 680 732, India

*Email: sunithatom@gmail.com

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ABSTRACT

Antioxidant compounds play a significant role in preventing and scavenging free-radicals by reducing oxidative stress and providing protection to humans against degenerative diseases and infections. Obviously, antioxidant molecules of plant origin are pivotal to combat the oxidative harm in cells. Present work intended to evaluate the antioxidant capacity of the fruits of *Spondias pinnata*. Methanol extracts of the fruits at two stages of maturity were prepared and investigated by various antioxidants analyses such as total antioxidant activity, reducing power and radical scavenging assays (DPPH, nitric oxide and hydrogen peroxide). Its total phenol, flavonoid and tannin contents were also determined. *Spondias pinnata* fruit extracts exhibited effective antioxidant activity and its IC₅₀ values of the unripe fruits were 65, 66, 72.23, 83.25, 66.75 µg/ml and ripe fruits were 124.24, 92.50, 97.66, 144.10, 72.25 µg/ml, for total antioxidant activity, reducing power, DPPH radical scavenging, nitric oxide radical scavenging and hydrogen peroxide scavenging assays respectively. The extracts, especially unripe fruit extract had good amounts of total phenolic and flavonoid contents which might contribute the antioxidant activities considerably. It is evident from the study that the fruits of *S. pinnata* possessed potent antioxidant activity and it can be considered as a good dietary choice among the underutilized fruits as well as common fruits. Therefore, wild mango may be a good choice of antioxidants of plant origin for dietary and pharmaceutical uses.

Introduction

Free-radicals are a collection of highly reactive molecules that impair the cellular functions by damaging nucleic acids, proteins and lipids (1, 2). Free radicals of cellular origin or from outside are one of the major agents for various diseases such as cancer, neurodegenerative diseases, cardiovascular diseases, diabetes and to even ageing (3). Antioxidant molecules (natural and synthetic) are considered as possible means for hindering and treating such diseases. Obviously, most of the synthetic molecules are found to be unsafe due to their possible carcinogenicity and toxicity (4). On the other hand, the intake of fruits and vegetables has a strong hindrance in developing such chronic diseases (5). In most cases, vitamins and secondary metabolites particularly polyphenols are considered to be responsible for such antioxidant activity (6). Studies on antioxidant activities of various fruits, vegetables,

spices, medicinal plants and even microalgae have shown the presence of rich amounts of natural antioxidants in them (7–9). Hence, the search for plants containing powerful antioxidants remains to be a focus of investigators.

Wild fruits are gaining increasing attention from pharmaceutical industries because of their nutritional value, vitamin and mineral contents and medicinal properties. With reference to their therapeutic characteristics, the antioxidant potential is the most commonly studied benefits (10). India and other tropical countries have an abundance of fruits in the wild and many of them belong to the underutilized category. Wild mango (*Spondias pinnata* (L.f.) Kurz.; Anacardiaceae) is such fruit and is mainly distributed in India, Sri Lanka and other southeast Asian countries (11, 12). It is chiefly found in the Western Ghats and north-eastern states of India. It is a medium-sized tree found in the

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deciduous to semi-evergreen forests and flowers from March to April. The fruits ripen early in November and available up to December (11, 12). Unripe fruits are preserved in brine (pickle) and are usually used in culinary preparations such as curries, jams, sherbet and condiments in places where it grows naturally (13). The nutritional value of this fruit is comparable to that of plum, apricot, cherry, peach and mango (12). Different parts of the plant, especially fruits, stem bark, leaves, and roots have been used in conventional medicinal preparations to treat various ailments such as bronchitis, ulcer, dysentery, diarrhoea, vomiting, skin diseases, dyspepsia and muscular rheumatism (14). The stem bark possesses ample amounts of phenolics and flavonoids and has free radical scavenging activities (15, 16) and anticancer properties (17). An early study (18) points out cytotoxic, antimicrobial and anti-inflammatory activities of essential oils obtained from fruit peel. The leaves and raw fruits have reported for its antibacterial, antioxidant (14), free radical scavenging activity and antitumor properties (12). However, no detailed studies of antioxidant and radical scavenging activities of unripe and ripe fruits of this plant from the Western Ghats are available. Hence, the present study is aimed to evaluate the antioxidant activities and to estimate the phenolic, flavonoid and tannin contents at two ripening stages of fruits of *S. pinnata*.

Materials and Methods

Collection of fruits and preparation of extract

The unripe (approximately 60 days after pollination) and ripe (approximately 220 days after pollination) fruits were collected randomly from natural populations of *S. pinnata* growing in the Vellikulam area (altitude 400–700 m) of Kottayam, Kerala, India. A total of 27 unripe and ripe fruits were divided into three replicates (n=3) with nine fruits per replicate. A voucher specimen (RHT65257) has been placed at St. Joseph's College, Tiruchirappalli.

The fruits were brought into the laboratory and washed with distilled water. The pericarp and mesocarp were separated together from seeds of unripe and ripe fruits and subsequently, air-dried for a short time and shade dried at room temperature (29 ± 3 °C). The dried pericarp and mesocarp were made into a fine powder and methanolic extract was prepared using Soxhlet apparatus (65 °C for 8 hr) from 100 gm powder. The extracts were concentrated using rotary evaporator (Rotavapor® R-210, BUCHI, Flawil, Switzerland) (temperature 40 °C and pressure 337 mbar) and kept at 4 °C for analysis.

Determination of total antioxidant capacity

Phosphomolybdenum technique was used to examine the total antioxidant capacity of unripe and ripe fruits of *S. pinnata* (19). 3 ml of the reagent solution [600 mM H₂SO₄, 28 mM Na₂HPO₄ & 4 mM (NH₄)₆Mo₇O₂₄] was transferred to various concentrations (25 µg, 50 µg, 75 µg, 100 µg, 125 µg &

150 µg) of the extract followed by incubation at 95 °C for 90 min. The mixture was allowed to cool and optical density was measured at 695 nm (Shimadzu, UV-150-02, Kyoto). Methanol and ascorbic acid were used as blank and reference compound respectively. The percentage total antioxidant capacity was calculated by using the formula:

$$(A_s/A_m) \times 100. \quad (i)$$

Here, A_m is maximum absorbance tested, A_s is the absorbance of the sample.

Determination of reducing power

To various concentrations (25 µg, 50 µg, 75 µg, 100 µg, 125 µg & 150 µg) of the extract, 0.2 M sodium phosphate buffer (2.5 ml, pH 6.6) and potassium ferricyanide (5 ml, 1%) were added. Trichloroacetic acid (5 ml, 10%) was transferred to the mixture after incubation (20 min at 50 °C). The reaction mixture was centrifuged and supernatant (5 ml) was mixed with distilled water (5 ml) and ferric chloride (1 ml, 1%). The optical density was measured at 700 nm. The reducing power of the samples at different concentrations was calculated by using the above formula (i). This method was slightly modified from the earlier described standard method (20).

Radical scavenging assay (1,1-diphenyl-2-picrylhydrazyl, DPPH)

The free radical scavenging capacity of the samples was analysed using DPPH radical (21). DPPH solution (1 ml, 0.1 mM) in methanol was added to the sample solution (25 µg, 50 µg, 75 µg, 100 µg, 125 µg & 150 µg) in methanol (3 ml). It was mixed thoroughly and kept in the dark (30 min) and the optical density was measured at 517 nm. DPPH radical scavenging efficacy was calculated using the following formula:

$$(\%) = ((A_0 - A_1)/A_0) \times 100 \quad (ii)$$

where A₀ and A₁ are absorbance values of the control and of the test samples respectively. Ascorbic acid was used as reference compound.

Radical scavenging assay (Nitric oxide, NO)

Griess Illosvoy reaction (22) was done to assess the nitric oxide scavenging capacity of the samples. To various doses (25 µg, 50 µg, 75 µg, 100 µg, 125 µg & 150 µg in 3 ml) of the sample solution in 10 mM sodium nitroprusside (dissolved in 0.5 M phosphate buffer, pH 7.4), Griess reagent (0.1% α-naphthyl-ethylenediamine in distilled water and 1% sulphanilamide in 5% H₃PO₄) was added after incubation for 60 min at 37 °C. The pink chromophore generated during the reaction was measured at 540 nm. Nitric oxide scavenging capacity (%) was calculated using the above equation (ii).

Radical scavenging assay (Hydrogen peroxide, H₂O₂)

Hydrogen peroxide radical scavenging was determined according to the standard method described (23). Different concentrations (25 µg, 50 µg, 75 µg, 100 µg, 125 µg & 150 µg) of the sample were mixed with 0.6 ml of 43 mM (in 0.1 M phosphate buffer, pH 7.4) hydrogen peroxide

solution. Optical density of the mixture was detected after 10 min at 230 nm. The inhibition activity (%) was calculated using the equation (ii).

Total phenolic content determination

Phenolic contents of the extracts were estimated using Folin-Ciocalteu method (24). A volume of 800 μ l Folin-Ciocalteu reagent and 2 ml sodium carbonate (7.5%) were added to 100 μ l of extract. Make the volume (diluted) to 7 ml using distilled water and was kept in dark (2 hr). The optical density was measured at 765 nm. Gallic acid was used as reference molecule and phenolic content was quantified as mg gallic acid equivalent (GAE)/100 gm dry weight of the extract (DW).

Total flavonoid content determination

It was estimated using AlCl_3 (25) method and quercetin was the reference molecule. To 0.3 ml distilled water, 100 μ l extract and 30 μ l NaNO_2 (5%) were added. 30 μ l of AlCl_3 (10%) was added to this after 5 min. Finally, 200 μ l of sodium hydroxide (1 mM) was transferred to the mixture after a lapse of 5 min. The test solution was diluted to 1 ml with distilled water before measuring the absorbance at 510 nm. The flavonoid content was quantified as mg quercetin equivalent (QEE)/100 gm DW of the extract.

Total tannin content determination

According to Folin-Denis method (26), 50 μ l of extract was diluted to 7.5 ml with distilled water. To this, Folin-Denis reagent (0.5 ml) and sodium carbonate (1 ml) were transferred. Finally, the volume of the mixture was made up to 10 ml by adding distilled water. Optical density was measured at 700 nm. Reference compound used was Tannic acid and tannin content quantified as mg tannic acid equivalent (TAE)/100 g DW of the extract.

Statistical analysis

All analysis was performed in three times for each group and results were given as mean ($n=3$) \pm S.D. and compared by Tukey's HSD tests. The fruit extracts and reference compound providing 50% inhibition (IC_{50}) were calculated from the graph as $\mu\text{g/ml}$ through the dose-response curve. Results were significant if $P \leq 0.05$. SPSS (Version 22.0) software was used for statistical analysis.

Results and Discussion

Total antioxidant activity

The total antioxidant capacity is based on the reduction of Mo (VI) to Mo (V) by metabolites present in the extract and consequently the formation of phosphate/Mo (V) complex at acidic conditions (19). The results of the total antioxidant activity of fruit extracts of *S. pinnata* and reference compound ascorbic acid are depicted in Table 1. The total antioxidant potential of unripe fruits was found to be promising with IC_{50} value of 65 $\mu\text{g/ml}$ (Table 6), which is equal to that of standard ascorbic acid (63.25 $\mu\text{g/ml}$). The results also show that there was no significant variation in total antioxidant capacity

at 50 $\mu\text{g/ml}$ and 100 $\mu\text{g/ml}$ concentrations of unripe fruit extract and ascorbic acid (Table 1). It was found that the ripe fruit extract required a quantity of 124.25 $\mu\text{g/ml}$ for reducing 50% (IC_{50}) of Mo (VI) to Mo (V). At the same time a concentration of 125 $\mu\text{g/ml}$ of unripe fruit extracts reduced 82% of Mo (VI) to Mo (V), i.e. methanol extract of unripe fruits has effective antioxidant potential than that of ripe fruits. The antioxidant activity was given most often by the phenolic compounds in the extracts and this might be reflected in the antioxidant activity of unripe and ripe fruit extracts of *S. pinnata* (27, 28). The unripe fruit extract had good amounts of phenolics (384.24 \pm 0.18), which were considerably different from that of mature fruit extract (243.13 \pm 0.29) (Table 7). Similar results were reported in *Psidium guajava* L. and *Nyssa fruticans* Wurm (29). In addition to phenolics, flavonoids and tannins have antioxidant potential to a certain extent (30, 31).

Phenolics are important phytoconstituents among various natural antioxidants because of their multiple biologic effects and direct contribution to antioxidant activity (27). According to an earlier study (28), the antioxidant activity of fruits and vegetables are most often correlated with the phenolic constituents. Various studies also demonstrated the wide medicinal applications of plant phenolics (32–34).

Reducing power assay

The methanol extracts of wild mango showed a substantial level of reducing activity. The results of the reducing power of the fruits at two stages of maturity are depicted in Table 2. Reducing capacity of the samples increased with increasing concentrations and significant difference ($P < 0.05$) was observed in reducing power between unripe and ripe fruits with IC_{50} values of 66 $\mu\text{g/ml}$ and 92.5 $\mu\text{g/ml}$ respectively. Reference molecule ascorbic acid exhibited IC_{50} values of 41.75 $\mu\text{g/ml}$ (Table 6). Among the two maturity stages, unripe fruits showed potent reducing power than that of the ripe fruits. The phytochemical analyses confirm that the unripe fruit extract was more abundant in phenolics and flavonoids than ripe fruits. The direct relationship of antioxidant activity with the reducing power of phytoconstituents was well studied on the orange pulp (Newhall variety) (35) and found that immature orange pulp has potent reducing power. Such a reduction in reducing capacity with maturity might be correlated with the reduction of phenolic contents and flavonoids in the fruits (36). Various other studies explain that the antioxidant activity attributed to reducing power could be affected by stages of maturity, geographical origin or cultivar, harvest time, storage time (37), storage conditions, temperature (38, 39) or exogenous usage of chemicals (40).

The reducing power indicates the capacity of a reducing agent to donate electrons and convert free radicals in to more stable form (41). The reducing power of wild mango, especially unripe fruit extract, was found to be higher which give emphasis to its enormous antioxidant potential. The results point out that methanol extract of *S. pinnata* fruits might

Table 1. Total antioxidant activity of methanol extracts of unripe and ripe fruits of *S. pinnata*.

Standard/ sample	Concentration ($\mu\text{g/ml}$)					
	25	50	75	100	125	150
Ascorbic acid	18.33 \pm 0.25 ^a	40.86 \pm 0.80 ^a	58.60 \pm 0.10 ^a	71.23 \pm 0.11 ^a	83.60 \pm 0.26 ^a	92.26 \pm 0.30 ^a
Unripe fruits	16.94 \pm 0.15 ^b	39.91 \pm 0.16 ^a	57.06 \pm 0.12 ^b	70.51 \pm 0.42 ^a	81.98 \pm 0.23 ^b	90.43 \pm 0.35 ^b
Ripe fruits	9.53 \pm 0.45 ^c	21.56 \pm 0.51 ^b	29.83 \pm 0.76 ^c	40.36 \pm 0.55 ^b	50.80 \pm 0.26 ^c	58.83 \pm 0.47 ^c

Values are mean of triplicate \pm S.D. Superscripts with the same letters within each column are not significantly different at $p < 0.05$.

Table 2. Reducing power of methanol extracts of unripe and ripe fruits of *S. pinnata*.

Standard/ sample	Concentration ($\mu\text{g/ml}$)					
	25	50	75	100	125	150
Ascorbic acid	31.13 \pm 0.25 ^a	58.90 \pm 0.10 ^a	74.65 \pm 0.13 ^a	86.80 \pm 0.10 ^a	97.18 \pm 0.10 ^a	100.00 \pm 0.00 ^a
Unripe fruits	27.10 \pm 0.20 ^b	42.40 \pm 0.21 ^b	54.36 \pm 0.13 ^b	66.56 \pm 0.14 ^b	78.63 \pm 0.20 ^b	89.42 \pm 0.18 ^b
Ripe fruits	16.50 \pm 0.43 ^c	28.43 \pm 0.40 ^c	40.46 \pm 0.51 ^c	54.33 \pm 0.32 ^c	60.56 \pm 0.45 ^c	68.30 \pm 0.60 ^c

Values are mean of triplicate \pm S.D. Superscripts with the same letters within each column are not significantly different at $P < 0.05$.

be converted the radical species into stable form and inhibited radical chain reaction. Previous study also showed the direct correlation between antioxidant activities and reducing power (42). Hence, reducing capacity may be taken as an important indicator of potent antioxidant capacity.

DPPH radical scavenging activity

DPPH radical-scavenging (Table 3) effect of methanol extracts of *S. pinnata* fruits was concentration-dependent mode and had an IC₅₀ value of 72.23 and 97.5 $\mu\text{g/ml}$ for the unripe and ripe fruits respectively, and that of ascorbic acid was 41 $\mu\text{g/ml}$ (Table 6). The DPPH radical scavenging analysis clearly showed a significant difference (Table 3) in the inhibition of radicals by unripe and ripe fruit extracts. The increased activity of unripe fruits might be due to the occurrence of several antioxidants and thus indicated its good antioxidant potential (26, 43). Previous studies showed that, the DPPH radical scavenging activity of pomegranate aril was decreased with ripening (44). Lowered radical inhibition ability with ripening might be attributed to reduction in total phenolics, conversion of anthocyanins and other biochemical changes (45).

DPPH radical scavenging is used as a good *in vitro* model to measure the antioxidant activity of phytoconstituents in a short time. Electron donors in the extracts could reduce the radical to a stable

diamagnetic molecule and it could be visualized by purple to yellow colour change (2). In the present study, scavenging of DPPH radical by the methanol extract of fruits of *S. pinnata* was lower than that of ascorbic acid. However, the extract exhibited appreciable scavenging activity, especially the unripe fruits and therefore, significant correlation between DPPH radical scavenging capacity and phenolic and tannin contents might be existed (2).

Nitric oxide scavenging activity

The results of this assay, as important as other radical scavenging activities of the extracts, was given in Table 4. Nitric oxide scavenging capacity of the extracts and the reference compound was increased with increasing concentrations. The 50% (IC₅₀) of radicals was scavenged by unripe fruit extract at a concentration of 83.25 $\mu\text{g/ml}$, while that of the ripe fruit extract was 144 $\mu\text{g/ml}$ (Table 6). Results of the study revealed that the unripe fruit extract found to be a better scavenger of nitric oxide than ripe fruit extract and significant difference ($p < 0.05$) was detected among three experimental conditions (unripe fruit extract, ripe fruit extract, and ascorbic acid). It is well known that continuous production of nitric oxide in mild quantities, lead to vascular collapse, whereas chronic expression leads to various carcinomas and inflammatory condition though it is a signalling molecule (46). Peroxynitrite

Table 3. DPPH radical scavenging activity of methanol extracts of unripe and ripe fruits of *S. pinnata*.

Standard/ sample	Concentration ($\mu\text{g/ml}$)					
	25	50	75	100	125	150
Ascorbic acid	38.40 \pm 0.34 ^a	56.43 \pm 0.23 ^a	69.18 \pm 0.16 ^a	80.21 \pm 0.25 ^a	92.58 \pm 0.07 ^a	100.00 \pm 0.00 ^a
Unripe fruits	18.18 \pm 0.17 ^b	34.72 \pm 0.14 ^b	51.68 \pm 0.27 ^b	63.99 \pm 0.20 ^b	76.06 \pm 0.22 ^b	87.95 \pm 0.10 ^b
Ripe fruits	11.36 \pm 0.50 ^c	25.63 \pm 0.55 ^c	38.53 \pm 0.45 ^c	51.46 \pm 0.41 ^c	59.26 \pm 0.47 ^c	67.53 \pm 0.55 ^c

Values are mean of triplicate \pm S.D. Superscripts with the same letters within each column are not significantly different at $P < 0.05$.

Table 4. Nitric oxide scavenging activity of methanol extracts of unripe and ripe fruits of *S. pinnata*.

Standard/ sample	Concentration ($\mu\text{g/ml}$)					
	25	50	75	100	125	150
Ascorbic acid	22.13 \pm 0.32 ^a	38.56 \pm 0.20 ^a	53.50 \pm 0.26 ^a	61.36 \pm 0.20 ^a	70.36 \pm 0.20 ^a	78.43 \pm 0.05 ^b
Unripe fruits	20.97 \pm 0.10 ^a	34.75 \pm 0.20 ^b	46.20 \pm 0.08 ^b	58.22 \pm 0.25 ^b	70.96 \pm 0.12 ^a	81.56 \pm 0.25 ^a
Ripe fruits	12.46 \pm 0.40 ^b	25.86 \pm 0.70 ^c	33.26 \pm 0.47 ^c	39.10 \pm 0.55 ^c	45.53 \pm 0.40 ^b	51.43 \pm 0.40 ^c

Values are mean of triplicate \pm S.D. Superscripts with the same letters within each column are not significantly different at $P < 0.05$.

Table 5. H₂O₂ scavenging activity of methanol extracts of unripe and ripe fruits of *S. pinnata*.

Standard/ sample	Concentration ($\mu\text{g/ml}$)					
	25	50	75	100	125	150
Ascorbic acid	32.53 \pm 0.30 ^a	54.49 \pm 0.39 ^a	68.50 \pm 0.20 ^a	81.31 \pm 0.10 ^a	88.23 \pm 0.21 ^a	96.70 \pm 0.20 ^a
Unripe fruits	23.33 \pm 0.17 ^b	38.65 \pm 0.08 ^b	55.62 \pm 0.22 ^b	67.41 \pm 0.37 ^b	78.39 \pm 0.22 ^b	87.04 \pm 0.07 ^b
Ripe fruits	18.54 \pm 0.33 ^c	32.31 \pm 0.33 ^c	52.38 \pm 0.40 ^c	65.53 \pm 0.40 ^c	71.70 \pm 0.43 ^c	76.43 \pm 0.37 ^c

Values are mean of triplicate \pm S.D. Superscripts with the same letters within each column are not significantly different at $P < 0.05$.

Table 6. The IC₅₀ values (µg/ml) of methanol extract of *S. pinnata* fruits and reference compound ascorbic acid.

Assays	Unripe fruits	Ripe fruits	Ascorbic acid
Total antioxidant activity	65 ^a	124.25 ^b	63.25 ^a
Reducing power	66 ^b	92.5 ^c	41.75 ^a
DPPH scavenging	72.23 ^b	97.5 ^c	41.0 ^a
Nitric oxide scavenging	83.25 ^b	144.0 ^c	68.5 ^a
Hydrogen peroxide scavenging	66.75 ^b	72.25 ^c	45.00 ^a

Superscripts with the same letters within each row are not significantly different at $P < 0.05$.

Table 7. Total phenolic, flavonoid and tannin contents of methanol extract of *S. pinnata* fruits.

Extract	Total phenolics (mg GAE/100 g DW)	Total flavonoids (mg QEE/100 g DW)	Total tannins (mg TAE/100 g DW)
Unripe fruits	384.24 ± 0.18	217.46 ± 0.36	72.28 ± 0.23
Ripe fruits	243.13 ± 0.29	183.87 ± 0.64	95.60 ± 0.25

Values are mean of triplicate ± S.D.

(ONOO[•]), a highly reactive species, would be formed when NO reacts with superoxide radical, this in turn increases the toxic effect (47). The present study proved that the fruit extracts of *S. pinnata* have good nitric oxide scavenging effect, especially the unripe fruit extract. Recent studies showed that phenolic compounds have greater NO scavenging capacity in surroundings with acidic pH (48). This may account for the higher nitric oxide radical scavenging activity of the unripe fruit extract.

Hydrogen peroxide scavenging activity

The H₂O₂ scavenging by methanol extracts of fruits of *S. pinnata* and the reference compound ascorbic acid were depicted in Table 5. The IC₅₀ values of unripe and ripe fruit extracts were 66.75 and 72.25 µg/ml respectively, and that of ascorbic acid was 45 µg/ml (Table 6). H₂O₂ is an oxidant which is being continuously formed in tissues as by-products of metabolism. As shown in Table 5, *S. pinnata* fruit extracts showed an effective H₂O₂ scavenging in a dose-dependent mode and have significant scavenging potential as reference compound. The scavenging of H₂O₂ by plant extracts may be attributed to their phenolics, which can donate electrons to H₂O₂ and neutralize it to water and the higher H₂O₂ scavenging activity of the unripe fruit extract was also correlated with amounts of total phenolics (49). It has been reported that hydrogen peroxide radical scavenging properties of medicinal fruits such as *Terminalia chebula* Retz. *T. bellirica* (Gaertn.) Roxb. and *Embllica officinalis* Gaertn. were found to be negligible, whereas that of *S. pinnata* showed a promising scavenging effect on H₂O₂ radical (50).

Total phenolic, flavonoid and tannin contents

Antioxidant activity is a fundamental property vital for life. A direct relationship exists between many of the biological processes, such as antiaging, anticarcinogenicity and antimutagenicity and the presence of natural antioxidants (28, 51, 52) of either exogenous or endogenous origin. The phytoconstituents such as phenolics, flavonoids and tannins contribute much to the antioxidant activity of fruits and vegetables (28, 52–55), which are good source of natural antioxidants. The phenolic compounds are the principal antioxidants, which scavenge free radicals, are widely distributed in plant kingdom (56).

Total phenolic content (Table 7) of wild mango was 384.24 ± 0.18 and 243.13 ± 0.29 mg GAE/100 gm DW of the unripe and ripe fruit extracts respectively. A significant difference in phenolic contents was found in ripe and unripe fruits of *S. pinnata* in the present study. This might be associated with the increased polyphenol oxidase activity at mature stages (57, 58), thereby an apparent decrease was observed at the ripe fruit extract. The polymerization of leucoanthocyanidins and hydrolysis of the arabinose ester of hexahydrodiphenic acid also contribute much to the reduction in phenolic contents at later stages of fruit development (59). The fruit phenolic content can be affected not only by ripeness but also by other factors such as species, variety, harvesting time, geography, cultivation, climate and storage conditions (60–62).

The results of the occurrence of flavonoids and tannins in relation to the fruit ripening is presented in Table 7. Flavonoids are benzopyrone derivatives, abundant in plants and shows antioxidant activity. The flavonoid contents of unripe and ripe fruits of *S. pinnata* was 217.46 ± 0.36 and 183.87 ± 0.64 mg QE/100 gm DW of the extracts respectively. Flavonoids are good for health because of their antioxidant and anti-inflammatory activities. These molecules hinder the low-density lipoprotein (LDL), the oxidation and facilitate cardioprotection (63). Present study indicates that the ample amounts of flavonoids in *S. pinnata* fruits substantiates its use as natural antioxidants. Additionally, the total tannin content of the unripe and ripe fruit extracts was 72.28 ± 0.23 and 95.60 ± 0.25 mg TAE/100 g DW mg of the extracts respectively (Table 7).

Flavonoids and tannins have found effective antioxidant activity through multiple actions such as scavenging of reactive oxygen species (ROS), hindering the pathways of ROS generation, chelating trace metals and reduce oxidizing radicals by donating hydrogen and their effects on human nutrition and health (51, 64). In the present study, the highest flavonoid contents were found in unripe fruit extract and highest tannin contents were observed in ripe fruit extracts. Earlier reports showed that various flavonoids converted to complex molecules such as tannins and lignins as the fruits became ripen (65). Consequently, due to change in phenolics, flavonoids and tannins with maturity, the ripe fruits of *S. pinnata* possessed

relatively lower quantities of flavonoids and phenolics as well as greater amount of tannins than unripe fruits.

In the present study, the highest total antioxidant activity, reducing power and different radical scavenging activities were displayed by unripe fruit extract. Therefore, the study revealed that there was a significant relationship between antioxidant capacity and phenolics and flavonoids contents as it was higher in the unripe fruit extract of *S. pinnata*.

Conclusion

The extracts of *Spondias pinnata* fruits, especially unripe extracts showed antioxidant potential which are as good as to that of reference compound ascorbic acid. From the present study, it could be recommended that ripening stage of *S. pinnata* fruits had effects on the amount of total phenolics, flavonoids and tannin contents which may directly be correlated with the antioxidant activity. In addition to phenolics, flavonoids and tannins, the raw fruits of *S. pinnata* (both ripe and unripe) may contain good amount of vitamin C (ascorbic acid) and hence, the actual antioxidant potential of these fruits may be higher than that obtained in the present study. Finally, we could suggest that *S. pinnata* fruits at any stage of maturity, especially the unripe fruits, be a good source of natural antioxidants and initiatives would be taken to procure the nutritional and medicinal benefits of this fruit.

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Authors' contributions

Both the authors have contributed equally to work.

Conflict of interests

The authors declare that we have no conflict of interest.

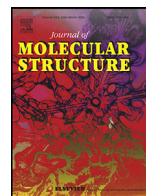
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Substituent effects in the formation of a few acenaphthenone-2-ylidene ketones and their molecular docking studies and in silico ADME profile

Daly Kuriakose[#], Roshini K. Thumpakara[#], Jesna A, Jomon P. Jacob^{*}

Department of Applied Chemistry, Cochin University of Science and Technology, Kochi-682 022, Kerala, India

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ABSTRACT

We observed intriguing substituent effects in the reaction between 4-substituted acetophenones and acenaphthenequinone in the presence of KOH in methanol. In all cases, expected Claisen-Schmidt condensation was the first step. However, depending on the nature of 4-substituent on acetophenone, the initially formed condensation product remain unchanged or underwent Domino sequence of reactions to give three different 2:2 adducts arising through three distinct pathways. The interactions of acenaphthenone-2-ylidene ketones with the target proteins were performed by molecular docking studies. The prediction of in silico ADME belongings of the synthesized compounds revealed substantial drug-likeness characters based on Lipinski's rules.

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1. Introduction

Claisen-Schmidt reaction, also called crossed-aldol condensation, is the condensation between aldehydes/ketones and carbonyl compounds leading to the formation of β -hydroxycarbonyl compounds which undergo subsequent dehydration to form α,β -unsaturated carbonyl compounds. This reaction is generally catalysed by acids or bases under room temperature or conventional heating [1,2] or microwave irradiation [3]. To avoid by-products and increase the yield of the products several protocols are developed using different catalysts [4–8]. β -Hydroxycarbonyl compounds have played a major role in synthetic organic chemistry [9–11] and α,β -unsaturated carbonyl compounds are widely used in pharma industries [12–15].

Acetophenone undergoes base catalysed Aldol condensation with benzil to form α,β -unsaturated ketone as the stable end product [16]. Based in this observation, we examined the Claisen-Schmidt reaction between acetophenone (**2a**) and acenaphthenequinone (**1**) in methanol in the presence of KOH [17,18]. Interestingly, we obtained three complex molecules by Michael-aldol

domino reaction sequence. These 2:2 domino products (**4a**, **5a**, **6a**) were formed from a common Claisen-Schmidt condensed product **3a** [17] and the detailed mechanism of the above reaction was established in our recent publication (Scheme 1) [18]. Even after repeated attempts we could neither isolate nor detect (GC-MS, LC-MS) the 1:1 adduct **3a**. However, we could successfully generate **3a** by alternative routes (*vide infra*).

Molecular docking studies were exploited to show the possible binding mode of the test molecule with its target protein aiming to explain its anticancer activity [19–21]. To study the drug like character of synthesised acenaphthenone-2-ylidene ketones (**3a-f**), we have explained with the help of Swiss ADME software.

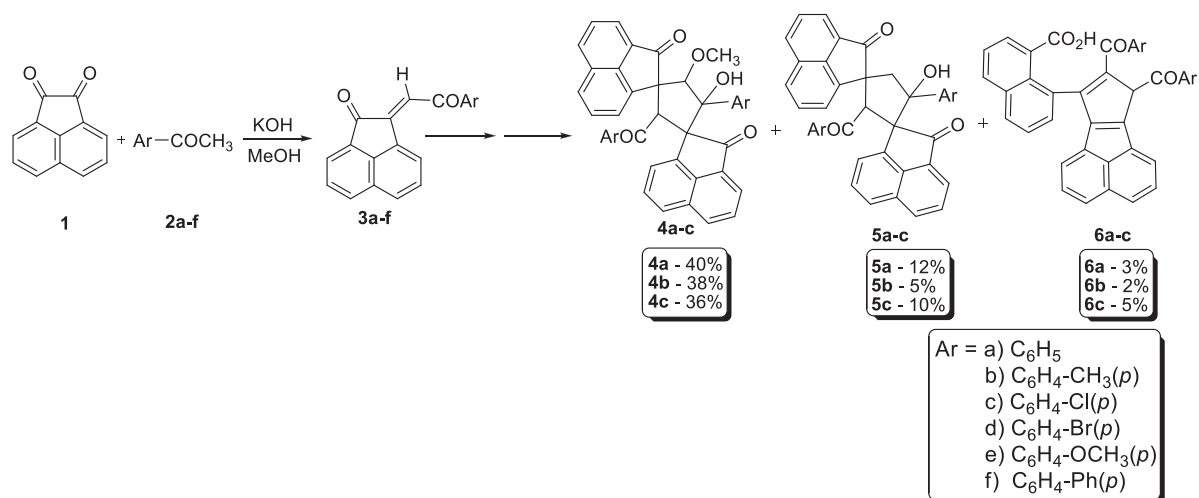
2. Results and Discussion

We have repeated the Claisen-Schmidt reaction of acenaphthenequinone (**1**) with acetophenones having different substituents at the 4-position (**2b-f**) to study the generality of the reaction. We observed dramatic substituent dependence in these reactions. While 4-chloro and 4-methylacetophenone reacted with acenaphthenequinone to give three 2:2 adducts (**4b**, **4c** - **5b**, **5c** - **6b**, **6c**) as described earlier [18], other acetophenone derivatives behaved differently, 4-bromo, 4-methoxy and 4-phenyl substituted acetophenones gave the expected 1:1 adduct, **3d-f** as the only product (Scheme 1). The 2:2 adducts formed were separated

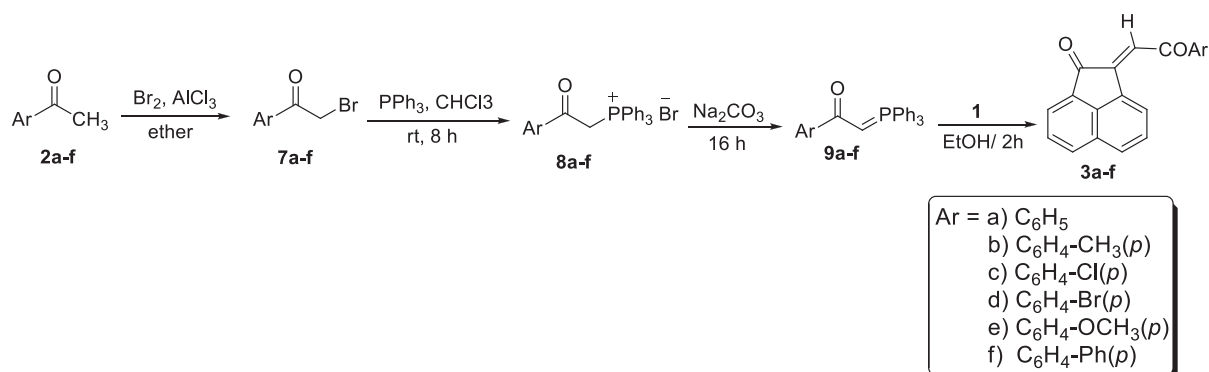
* Corresponding author.

E-mail address: jacobpjomon@yahoo.com (J.P. Jacob).

[#] These two authors contributed equally.



Scheme 1. Reaction between acenaphthenequinone (**1**) and acetophenones (**2a-f**).



Scheme 2. Wittig route for the synthesis of acenaphthene-2-ylidene ketones (**3a-f**).

by column chromatography and purified by recrystallization. The compounds were characterised by ¹H, ¹³C NMR and SCXRD [18,22,23] analyses. Inductive, mesomeric and steric factors could not satisfactorily account for the dichotomous reaction sequence of acetophenone-acenaphthenequinone reaction.

Our further investigations to unravel the mechanism of the reaction pointed towards a remarkable substituent effect in controlling the reactivity of acenaphthene-2-ylidene ketones (**3a-f**). We have independently synthesised the intermediate acenaphthene-2-ylidene ketones **3a-f** by adopting the Wittig route (Scheme 2). In this reaction sequence, phenacyl bromides **7a-f** were first synthesised by the bromination of various para-substituted acetophenones **2a-f** using diethyl ether as solvent in the presence of anhydrous aluminium chloride. Phenacyl bromide derivatives **7a-f** were converted to corresponding phenacyltriphenylphosphonium bromides **8a-f** by the reaction with triphenylphosphine. In the presence of sodium carbonate, corresponding ylides **9a-f** were formed and they reacted with acenaphthenequinone (**1**) to form required acenaphthene-2-ylidene ketones **3a-f**.

Independently synthesised acenaphthene-2-ylidene ketones **3a-c** were treated with KOH in methanol. While **3d-f** remained unchanged even after refluxing for 12 h, **3a-c** underwent further transformation to give the 2:2 adducts **4a-c** within 4 h. This observation supports the reaction sequence depicted in Scheme 1 indicating further transformations of **3** to give **4** and presumably, **5** and **6** attesting the role of remote substituents in the reactivity of acenaphthene-2-ylidene ketones **3a-f**.

Diversity of the above reaction may depend on the geometry or electronic factors of acenaphthene-2-ylidene ketones (**3a-f**) having different substituents. To study the effect of geometry, we have computationally optimized the geometry of acenaphthene-2-ylidene ketones (**3a-f**) using the software Gaussian (Table 1).

Based on optimized structures collected in Table 1, it is clear that acenaphthene-2-ylidene ketones **3a-f** have similar geometry and hence geometry is not a significant factor in controlling the reactivity of **3**. So the difference in reactivity of **3a-f** may be due to electromeric effects induced by substituents at the *para* position of the benzoyl group in the 1:1 adducts, **3a-f**. A clear correlation is elusive since both electron withdrawing (Cl) and electron releasing (CH₃) substituents assist 2:2 adduct formation while both Br and -OMe substituents rendered the initially formed 1:1 adducts unreactive towards further transformations under the conditions employed by us.

3. Molecular docking

The AutoDock is an automatic docking programme designed for the prediction of the binding among small molecules for example drug candidates and the receptor having known 3D structure [24–30]. Molecular docking studies were performed using AutoDock 4.2 Vina software to confirm the anticancer activity of acenaphthene-2-ylidene ketones (**3a-f**) against different proteins viz **4I4T**, **4I55**, **4YJ2** and **4YJ3**. Crystal structure of the target proteins were downloaded from the RSCB PDB website in the PDB

Table 1
Energy minimized structures of acenaphthenone-2-ylidene ketones (**3a-f**) using Gaussian.

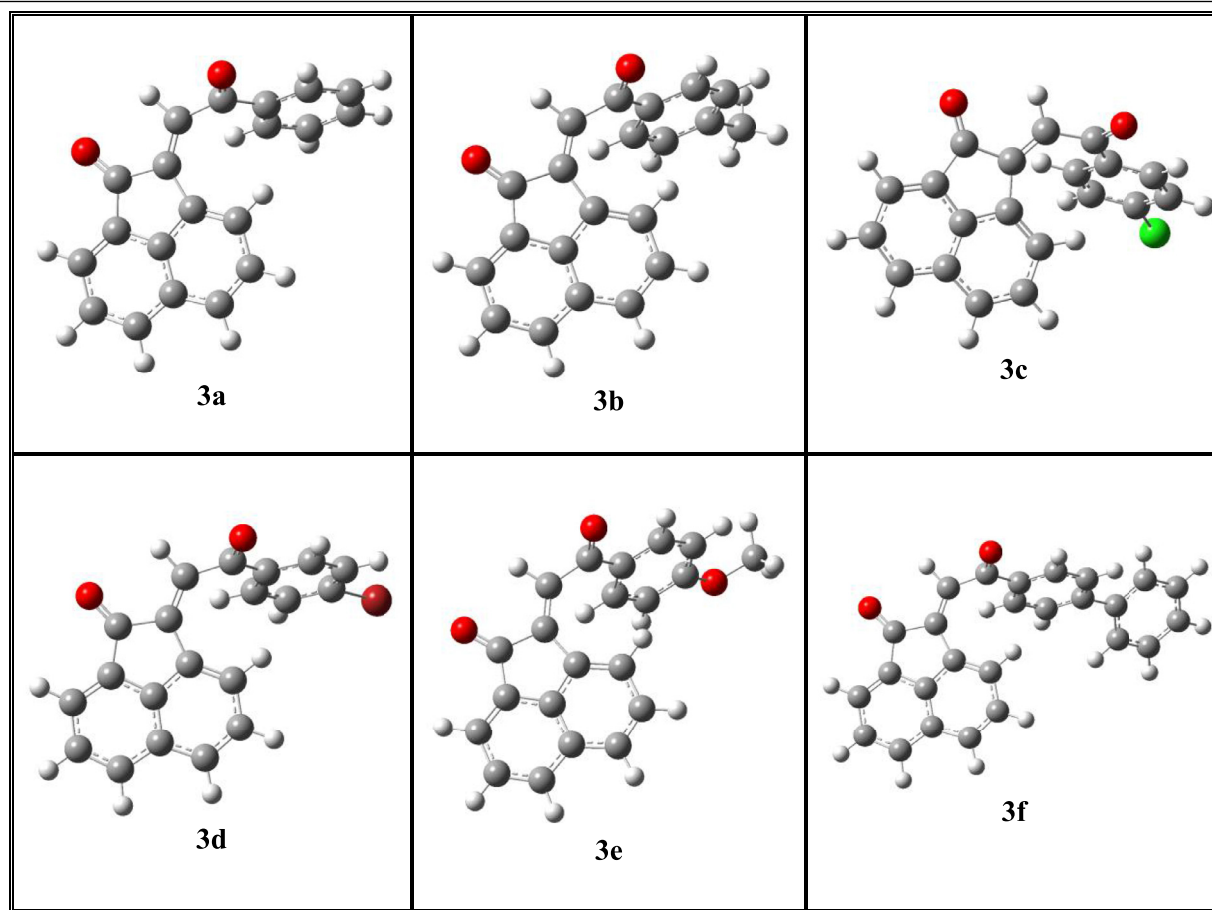


Table 2
All interacting residues between acenaphthenone-2-ylidene ketones and selected target proteins.

Proteins	Molecules	All interacting residues
4I4T	3a	ARG F: 44, PHE F: 49, ARG F: 66, ALA F: 68, ASP F: 69, ALA F: 335.
	3b	VAL F: 13, ALA F: 68, LEU F: 314, ALA F: 335, PRO F: 336.
	3c	PHE F: 49, ALA F: 68, ASP F: 69, ARG F: 73
	3d	ARG F: 44, ARG F: 46, PHE F: 49, ARG F: 66, ALA F: 68, ASP F: 69, ALA F: 335.
	3e	ARG F: 44, LEU F: 47, PHE F: 49, ARG F: 66, ALA F: 68, ASP F: 69, ALA F: 335.
	3f	ARG F: 44, ARG F: 46, PHE F: 49, ARG F: 66, ALA F: 68, ASP F: 69, ALA F: 335.
4I55	3a	GLY B: 10, CYS B: 12, GLU B: 71, ALA B: 99, ASN B: 101, THR B: 145, GLY B: 146, ASP B: 179.
	3b	GLN B: 11, CYS B: 12, GLU B: 71, ASN B: 101, GLY B: 144, VAL B: 171, PRO B: 173.
	3c	VAL B: 177, ASP B: 179, TYR B: 224, LEU B: 227, VAL C: 250, VAL C: 353.
	3d	CYS B: 12, SER B: 140, VAL B: 171, MET B: 172, PRO B: 173.
	3e	GLN B: 11, CYS B: 12, GLU B: 71, ALA B: 99, ASN B: 101, GLY B: 144, VAL B: 177, ASP B: 179.
	3f	TYR B: 224, LEU C: 248, PRO C: 325, VAL C: 353.
4YJ2	3a	VAL B: 177, SER B: 178, LEU C: 248, PRO C: 325, VAL C: 353, ILE C: 355.
	3b	VAL B: 177, SER B: 178, TYR B: 224, LEU B: 227, LEU C: 248, PRO C: 325, VAL C: 353, ILE C: 355.
	3c	VAL B: 177, TYR B: 224, LEU C: 248, PRO C: 325, VAL C: 353, ILE C: 355.
	3d	LYS B: 105, LYS C: 163.
	3e	CYS B: 12, GLN B: 15, GLU B: 71, ALA B: 99, GLY B: 144, THR B: 145, GLY B: 146, ASP B: 179.
	3f	SER B: 178, LEU C: 248, GLY C: 350, PHE C: 351, VAL C: 353.
4YJ3	3a	VAL B: 177, LEU C: 248, PRO C: 325, ILE C: 355, VAL C: 353.
	3b	CYS B: 12, GLU B: 71, ALA B: 99, ASN B: 101, GLY B: 144, THR B: 145, GLY B: 146, ASP B: 179, TYR B: 224.
	3c	GLY B: 11, CYS B: 12, TYR B: 224
	3d	VAL B: 177, VAL C: 250.
	3e	GLN B: 11, CYS B: 12, GLY B: 142, GLY B: 143, TYR B: 224.
	3f	VAL B: 177, TYR B: 224, LYS C: 352.

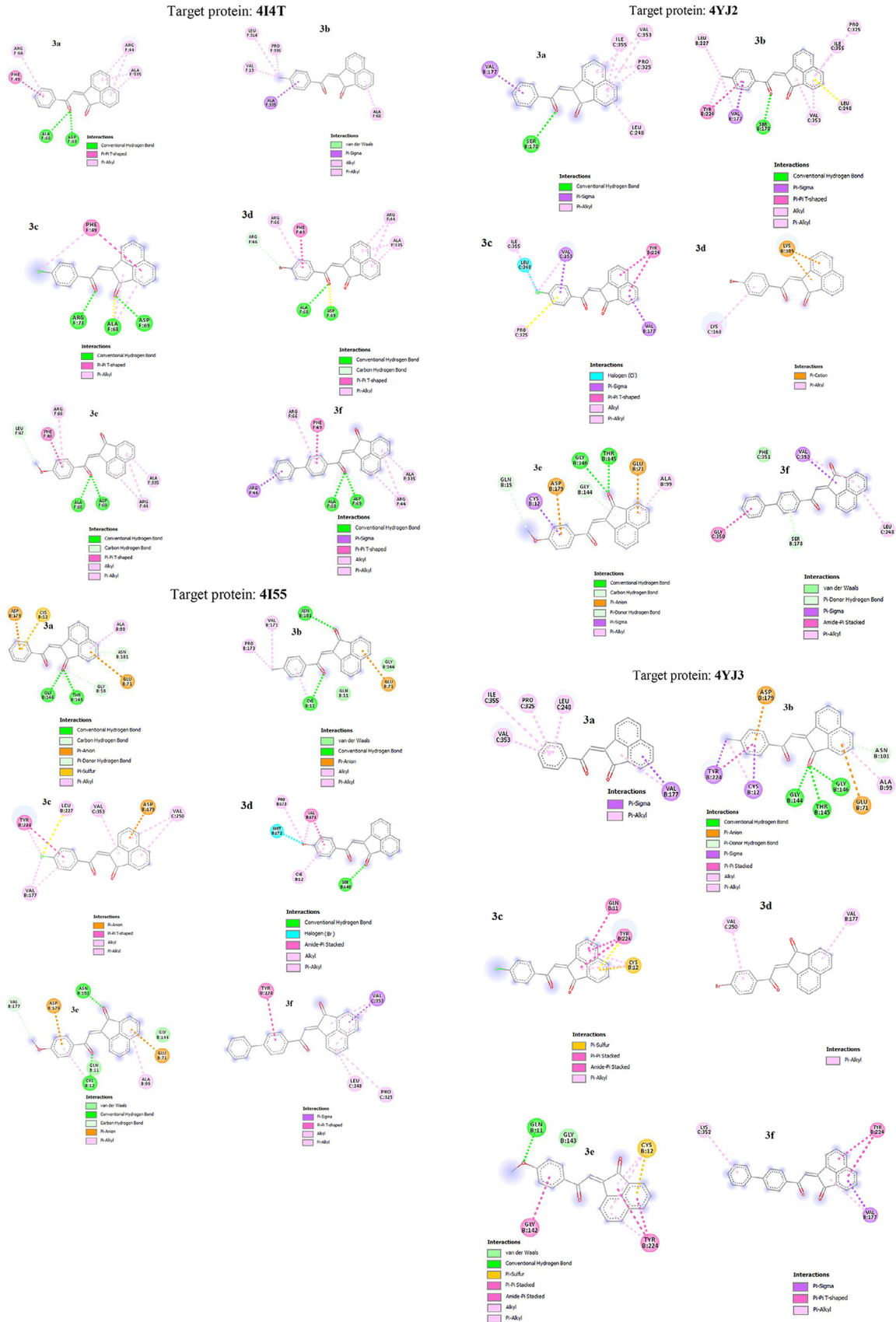


Fig 1. 2D diagram of acenaphthenone-2-ylidene ketones docked into the binding site of anti-cancer proteins.

Table 3
Prediction of in silico ADME properties of the acenaphthenone-2-ylidene ketones, **3a-f**.

Acenaphthenone-2-ylidene ketones	Molecular weight (g/mol)	Physicochemical parameters					Bioactivityscore
		Mi log P	TPSA (Å ²)	No. of H-bond acceptor	No. of H-bond donor	No. of rotatable bonds	
3a	284.31	2.66	34.14	2	0	2	0.55
3b	298.33	2.59	34.14	2	0	2	0.55
3c	318.75	2.90	34.14	2	0	2	0.55
3d	363.20	3.01	34.14	2	0	2	0.55
3e	314.33	2.47	43.37	3	0	3	0.55
3f	360.40	3.31	34.14	2	0	3	0.55

format [31]. Before docking, the water molecules and other co-crystallized ligand molecules were removed from the target proteins and polar hydrogens were added using PyMoL software [32]. The active site of the protein was explained within the grid size 30Å × 30Å × 30Å in order to incorporate the residues of the active sites. The best fit conformation was analysed, which is based on the binding score, hydrogen bonding and other hydrophobic interactions. The binding interactions were visualized using Discovery studio visualizer. Affinity of best docked position of the molecule and protein target complex was determined by E-value (kcal/mol). It provides the prediction of binding free energy for docked molecule [21].

4I4T crystal structure of the tubulin-RB3-TTL-Zampanolide complex with binding energy (E) -9.20, -9.60, -8.80, -9.50, -9.30, -10.70 kcal/mol for **3a**, **3b**, **3c**, **3d**, **3e** and **3f** respectively. Organisms: *Bos taurus*, *Rattus norvegicus*, *Gallus gallus*. **4I55** Crystal structure of the tubulin-stathmin-TTL complex with binding energy (E) -9.00, -9.10, -7.80, -8.40, -8.40, -9.30 kcal/mol for **3a**, **3b**, **3c**, **3d**, **3e** and **3f** respectively. **4YJ2** Crystal structure of tubulin bound to MI-181 with binding energy (E) -8.60, -8.60, -8.80, -8.50, -8.70, -9.70 kcal/mol for **3a**, **3b**, **3c**, **3d**, **3e** and **3f** respectively. **4YJ3** crystal structure of tubulin bound with binding energy (E) -8.70, -8.80, -9.00, -8.10, -8.70, -9.40 kcal/mol for **3a**, **3b**, **3c**, **3d**, **3e** and **3f** respectively. From the above data, we can clear that 2-(2-(biphenyl-4-yl)-2-oxoethylidene)acenaphthylene-1(2H)-one (**3f**) shows good binding affinity to target proteins as shown in Fig 1. So, we can use **3f** as the best anticancer drugs in the acenaphthenone-2-ylidene ketones (**3a-f**) series. These acenaphthenone-2-ylidene ketones (**3a-f**) show good binding affinity to the target proteins than the binding affinity of the compounds to the same target proteins in a recently reported article [33].

By using Discovery studio visualizer, [34] we have to find the docking interaction of hydrogen bonds (classical and non-classical) and binding amino acid residues: alanine (ALA), asparagine (ASN), arginine (ARG), aspartic acid (ASP), cysteine (CYS), glutamine (GLN), glutamic acid (GLU), glycine (GLY), histidine (HIS), leucine (LEU), lysine (LYS), serine (SER), threonine (THR), tryptophan (TRP), tyrosine (TYR), valine (VAL) and phenylalanine (PHE) showed in the 2D interaction diagram (Fig 1).

4. In silico ADME property prediction

Computational simulation studies provide a quick and economic approach to determine the drug-like character of synthesized acenaphthenone-2-ylidene ketones, **3a-f**. SwissADME software was used to measure their bioactive score value of the prepared compounds. It was measured by estimating the different parameters Mi log P (partition coefficient), compound weight, heavy atoms, hydrogen donors, hydrogen acceptors and rotatable bonds Table 3.

Properties of absorption, distribution, metabolism, excretion and toxicity are included in In silico ADME and are exploited to predict the drug-likeness behaviour of the compounds based on Lipinski's rule of five [35–37]. According to Lipinski's rule, Mi log P values of compounds should be below 5, molecular weight is lower than 500, H-bond acceptors should be smaller than 10, H-bond donors should be lower than 5 and should have the bioactive score is smaller than one.

Mi Log P, is calculated by the methodology developed by Molinspiration [38] as a sum of fragment based contributions and correction factors. To determine the hydrophobic character of the synthesized compounds we are using the parameter Mi log P, which is necessary for analyzing the permeability skill of the compounds across the cell membrane. In the present study about the acenaphthenone-2-ylidene ketones **3a-f**, Mi log P values are found to be less than 5; it implies that the compounds should have appreciable penetrable talent across the central nervous system. The molecular weight of the synthesized compounds is less than 500. As per Lipinski regulation, these compounds have good drug-likeness criteria.

Here the number of H-acceptors is 2, 3 and the H-donor is zero for acenaphthenone-2-ylidene ketones, **3a-f**. Based on the Lipinski's rule of five, the compounds possess many H- acceptors and donors, they effectively interact with active sites. Topological molecular polar surface area (TPSA) is a commonly analyzed factor related to H-bonding (O and N atom counts) and is necessary to identify the cell permeability phenomena of **3a-f**. It is a significant parameter that was compared with the passive diffusion through the cell wall; hence, it agreed to pass the drug candidates inside the central nervous system. In the case of acenaphthenone-2-ylidene ketones **3a-f**, acquires TPSA values below 140 Å² and thereby possess good drug transport features and may be favoured for oral administration.

As per Lipinski's rule, molecule having higher number of rotatable bond, they become more stretchy and convenient for interface with the accurate active centre. Here the rotatable bonds are 2, 3 and have well-matched ability to interact with the living cells efficiently.

According to the Lipinski's rule, the compounds which possess bioactivity scores greater than 0 have excellent drug likeness proficiency [39]. In this case, acenaphthenone-2-ylidene ketones **3a-f**, have the bioactivity score is 0.55 and are scrutinized by measuring the activity score of GPCR (Human G-protein coupled receptors) ligand, ion channel modulator, nuclear receptor ligand, kinase inhibitor, protease inhibitor and enzyme inhibitor.

5. Conclusion

Acenaphthenone-2-ylidene ketones were independently synthesised and their propensity to undergo further transformations under conditions employed for Claisen-Schmidt reaction was examined. Geometry optimization using Gaussian, clearly revealed

that acenaphthenone-2-ylidene ketones have similar geometry, hence geometry has no role in controlling the Claisen-Schimidt reaction of acenaphthenone-2-ylidene ketones. Electromeric effects induced by substituents at the *para* position of the benzoyl group in the initially formed acenaphthenone-2-ylidene ketones may be responsible for the observed difference in their reactivity towards further transformations. Anticancer activity of the acenaphthenone-2-ylidene ketones were analysed (in silico) using AutoDock 4.2 Vina software. Drug likeness of the acenaphthenone-2-ylidene ketones were established using SwissADME software based on Lipinski's rule of five.

6. Experimental section

6.1. General methods

All reactions were conducted in oven-dried glassware. Reagents used were purchased from Sigma Aldrich Chemical Co. or Spectrochem and were used without further purification. Solvents used for experiments were distilled and dried according to procedures given in standard manuals. All reactions were monitored by thin layer chromatography (TLC). Analytical thin layer chromatography was performed on aluminium sheets coated with silica gel (Spectrochem); visualization was achieved by exposure to iodine vapours or UV radiation. Solvent removal was done on a Heidolph rotary evaporator. Gravity column chromatography was performed using 60-120 mesh silica gel (Spectrochem) and mixtures of hexane-ethyl acetate were used for elution. Melting points were recorded on a Neolab melting point apparatus. Infrared spectra were recorded using JASCO FTIR 4100 spectrometer. NMR spectra were recorded a 400 MHz on a Bruker FT-NMR spectrometer. Chemical shifts are reported in δ (ppm) relative to TMS as the internal standard. Single Crystal XRD was done by Bruker XRD Instrument. Elemental analysis was performed using Elementar Systeme (Vario EL III). Molecular mass was determined by fast atom bombardment (FAB) using JMS 600 JEOL mass spectrometer. Unless otherwise mentioned, all commercially available solvents and reagents were used as received and reactions were performed under normal conditions. Characterization data for **4a-c**, **5a-c** and **6a-c** are available in earlier publications from our group [17,18].

6.2. Common procedure for the synthesis of acenaphthenone-2-ylidene ketones (3a-f) by Wittig's reaction

Para substituted acetophenones (**7a-f**, 25 mmol) was slowly added to a chloroform solution (6 mL) of triphenylphosphine (25 mmol) and the solution was filtered into anhydrous ether (1 Litre). The precipitate formed was filtered, collected and dried. The product formed was recrystallized from water in the form of white powder (**8a-f**, 60-68%).

A mixture of corresponding triphenylphosphonium bromide (**8a-f**, 7.0 g) and 10% aqueous sodium carbonate (250 mL) was well mixed for 15h. The mixture was filtered and insoluble portion was taken up in hot benzene (200 mL). Some unreacted bromide was removed by filtration; addition of petroleum ether to the benzene filtrate afforded the compound **9a-f** (58-65%) as white powder.

A solution of acenaphthenequinone (**1**, 27 mmol) and triphenylphosphinebenzoylmethylene (**9a-f**, 27 mmol) in ethanol (30 mL) was stirred at room temperature for 2h. The product was separated, filtered and purified by recrystallization from ethanol-chloroform (1:3) mixture to give acenaphthenone-2-ylidene ketones **3a-f** (57-68%).

2-(2-oxo-2-phenylethylidene)acenaphthylene-1(2H)-one (3a) [17,18,40]: Yellow needles, Yield: 3.18 g (60%), mp: 108-110°C, IR ν_{\max} (KBr): 1722, 1671 cm^{-1} (C=O), $^1\text{H NMR}$ (CDCl_3): δ 8.97-7.26 (12H, m, aromatic and vinylic protons), $^{13}\text{C NMR}$ (CDCl_3):

δ 200.32, 199.21, 141.13, 140.84, 138.10, 134.86, 133.25, 131.02, 130.87, 130.38, 129.23, 128.40, 128.33, 127.62, 126.12, 123.19, 118.29, 96.43. MS (FAB): m/z 284 (M^+), 105. Elemental analysis calculated for $\text{C}_{20}\text{H}_{12}\text{O}_2$: C 84.49, H 4.25. Found: C 84.43, H 4.39.

2-(2-oxo-2-p-tolylethylidene)acenaphthylene-1(2H)-one (3b) [17,18,40]: Yellow needles, Yield: 3.39 g (64%), mp: 143-145°C, IR ν_{\max} (KBr): 1710, 1674 cm^{-1} (C=O), $^1\text{H NMR}$ (CDCl_3): δ 8.97-7.21 (11H, m, aromatic and vinylic protons), 2.40 (3H, singlet, methyl protons) $^{13}\text{C NMR}$ (CDCl_3): δ 200.16, 199.34, 153.81, 144.29, 134.93, 134.47, 132.01, 131.34, 131.34, 130.31, 129.80, 129.51, 129.51, 129.64, 127.50, 127.17, 126.81, 122.52, 25.80. MS (FAB): m/z 295 (M^+), 119. Elemental analysis calculated for $\text{C}_{21}\text{H}_{14}\text{O}_2$: C 84.54, H 4.74. Found: C 84.48, H 4.76.

2-(2-(4-chlorophenyl)-2-oxoethylidene)acenaphthylene-1(2H)-one (3c) [17,18,40]: Yellow needles, Yield: 3.60 g (68%), mp: 187-189°C, IR ν_{\max} (KBr): 1716, 1668 cm^{-1} (C=O), $^1\text{H NMR}$ (CDCl_3): δ 8.81-7.14 (11H, m, aromatic and vinylic protons), $^{13}\text{C NMR}$ (CDCl_3): δ 200.4, 194.21, 140.93, 140.14, 139.10, 134.99, 132.05, 131.54, 130.77, 130.18, 129.08, 128.45, 128.39, 127.92, 126.85, 122.09, 117.99, 96.19. MS (FAB): m/z 318 (M^+), 139. Elemental analysis calculated for $\text{C}_{20}\text{H}_{11}\text{ClO}_2$: C 75.36, H 3.48. Found: C 75.39, H 3.41.

2-(2-(4-bromophenyl)-2-oxoethylidene)acenaphthylene-1(2H)-one (3d) [17,18,40]: Yellow needles, 2.62 g (57%), mp: 197-199°C, IR ν_{\max} (KBr): 1710, 1663 cm^{-1} (C=O), $^1\text{H NMR}$ (CDCl_3): δ 8.80-7.12 (11H, m, aromatic and vinylic protons), MS (FAB): m/z 362 (M^+), 183. Elemental analysis calculated for $\text{C}_{20}\text{H}_{11}\text{BrO}_2$: C 66.14, H 3.05. Found: C 66.18, H 3.11.

2-(2-(4-methoxyphenyl)-2-oxoethylidene)acenaphthylene-1(2H)-one (3e) [17,18,40]: Yield: 2.90 g (63%), mp: 161-163°C, IR ν_{\max} (KBr): 1722, 1670 cm^{-1} (C=O), $^1\text{H NMR}$ (CDCl_3): δ 8.84-6.91 (11H, m, aromatic and vinylic protons), 3.88 (3H, singlet, methoxy protons), $^{13}\text{C NMR}$ (CDCl_3): δ 193.66, 189.13, 164.04, 140.70, 138.22, 132.62, 131.31, 131.24, 130.80, 130.47, 129.84, 129.12, 128.37, 121.93, 117.69, 115.41, 114.62, 114.13, 113.98, 113.05, 110.99, 108.72, 107.71, 106.09, 104.37, 96.22, 55.40. MS (FAB): m/z 314 (M^+), 135. Elemental analysis calculated for $\text{C}_{21}\text{H}_{14}\text{O}_3$: C 84.54; H 4.73. Found: C 84.50, H 4.69.

2-(2-(biphenyl-4-yl)-2-oxoethylidene)acenaphthylene-1(2H)-one (3f) [17,18,40]: Yield: 2.76 g (60%), mp: 187-189°C, IR ν_{\max} (KBr): 1715, 1650 cm^{-1} (C=O), $^1\text{H NMR}$ (CDCl_3): δ 8.78-7.25 (16H, m, aromatic and vinylic protons), $^{13}\text{C NMR}$ (CDCl_3): δ 201.89, 194.87, 146.41, 140.11, 135.31, 132.47, 132.37, 131.43, 130.81, 129.47, 128.94, 128.83, 128.39, 128.23, 127.79, 127.40, 127.14, 126.69, 126.48, 124.04, 122.04, 117.87, 112.89, 109.54, 108.14, 96.22. MS (FAB): m/z 360 (M^+), 181. Elemental analysis calculated for $\text{C}_{26}\text{H}_{16}\text{O}_2$: C 86.64, H 4.47. Found: C 86.68; H 4.42.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.molstruc.2020.129209.

CRediT authorship contribution statement

Daly Kuriakose: Software, Formal analysis, Investigation, Data curation, Writing - original draft. **Roshini K. Thumpakara**: Investigation, Writing - original draft, Data curation, Formal analysis. **Jesna A**: Visualization, Investigation. **Jomon P. Jacob**: Conceptualization, Methodology, Supervision.

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The Diaspora Reflections and Indian fatalism in Kamala Markandaya's novel *Nectar in a Sieve*

HIMA HARRY

ASSISTANT PROFESSOR ON CONTRACT

DEPARTMENT OF ENGLISH

CARMEL COLLEGE MALA

Abstract:

This study tends to focus upon the Diaspora reflections and Indian fatalism in Kamala Markandaya's Nectar in a Sieve. Kamala Markandaya was an Indian novelist. She wrote about the political, cultural and economical clashes between Indian urban and rural life. Nectar In a Sieve describes the story of an Indian peasant woman, Rukmani. She was married to a tenant farmer when she was twelve years old. Her life is absolutely an endless struggle for survival and protection of her dearest ones. This novel is mainly based on a cultural clash of the two modes of life. The picturization of Western and Oriental life is clearly reflected diasporic elements in the novel. Kamala Markandaya is regarded as the shining star of Indian Diaspora literature. Markandaya had enabled herself to travel widely in South India and England. She explains the events of the story which is interconnected with Diasporic representations. Nectar In a Sieve , is subtitled as "A Novel of Rural India", exhibits the industrialisation and its consequences. This novel explores badly to the life style of Indian villagers.

Keywords: Diaspora, Indian fatalism, Industrialisation, Disintegration and Degradation

Nectar in a Sieve is the first novel of Kamala Markandaya. This novel is set in India during the period of urban development. Kamala Purnaiya Taylor, was an Indian novelist and journalist. She completed her graduation from Madras University. In 1948, she moved to England and married a journalist, Bertrand Taylor. This novel is mainly conflicted with Eastern and Western themes.

Diaspora Representation in *Nectar in a Sieve*

Rukmani is the woman narrator of the novel. She tells her story in a reminiscent mood. She remembers the events long after they have happened. The first part of the novel narrates the married life of Rukmani and Nathan. Their life efforts for survival could not become a success. The Diaspora reflections are described through their whole life. The image of tannery provided many job opportunities to the poor peasants. Rukmani's own sons got job there. One of them was killed and other two sons left them and went to Ceylon. Rukmani's daughter's life is not satisfactory. Their daughter Ira was engaged in prostitution for helping her parents. Finally, they were forced to leave the village. But their destiny would not end there. The city life did not welcome them. They were not smart enough to fit into city's busy and energetic life. They lost their belongings in the temple and became isolated. Nathan died one day on the way back to the temple from the quarry. Rukmani had no option but forced to return to the village life. The sense of isolation and forceful plight of her life shows diasporas elements in the novel.

East-West Theme

Kamala Markandaya introduced many western characters in her novels. Dr. Kenny, is therepresentative of the western characters. He has left his family and his own country to serve the poor and suffering people in India. He has a simple, sincere and frank nature in is character. He is very patiently treated Rukmani and her daughter Ira in their childless condition.

Dr. Kenny is a good foreign missionary doing his best for the backward class of our country.

His neutral observation of life in India and his free communication with rural people exhibit

East- West relations . Her East- West themes also reflected Diaspora elements in the novel'

Nectar In a Sieve.

Tannery is presented as a symbol of western technology and science. It's disintegrating Impact is described in the novel. This novel *Nectar In a Sieve* shows diasporas elements by the reflections of Tradition-Modernity, Industrial-agricultural tensions and restlessness are also brought in.

Industrialisation and Disintegration

Nectar in a Sieve is obviously a story of the modernisation of Indian villages. This novel highlights disintegrating and corrupting impact of modernity. The modern tannery disturbs rural life of the Indian Villagers. It is also caused for the disintegration of the family life of Rukamani and Nathan. Dr. Krishna Rao puts it, "Nathan and Rukmani are Representatives of the thousands of uprooted peasants under an Industrial economy" (Dr. Tilak 62).

Rukmani, a typical agricultural woman regards the tannery is the root-cause of their Tragedy. It creates social degradation among the villagers. Ira is committed for Prostitution because of hunger. Thus the tannery is also an instrumental in bringing this Degradation to the people.

Industrialisation of a rural country creates a number of problems to the village people. Prices begin to increase. The farmers could not meet their demands and needs. Hardship, Hunger and starvation are true results of this industrialisation. Finally, they are forced to Migrate to some industrial town. Their migration and forceful existences in the city also explore the diasporas themes.

Indian Fatalism

This novel revolves around Indian culture and life style. Rukmani is married to Nathan at Younger age. He is more older than her. But she is happily lived with him as a typical Indian woman. She comes to think her marriage as an ideal marriage. She is the role model of Indian woman and culture.

Rukmani's self-surrender to her husband and her independent nature to her children are clear descriptions of Indian suffering women. Nathan's life is also a symbolic replica of Indian village man. Nathan is a poor farmer who cannot able to pay his landlord. He was deeply rooted in his land. The tannery forced him to lose his land. Both Nathan and Rukmani migrated to city life for seeking shelter with their son Murugan. They are leading a life of complete poverty, hunger and disease.

Conclusion

This novel is considered as a 'novel of Hunger'. 'Hunger' is the most important problem expressed in this novel. Hunger degrades and disintegrates Indian family life.

Kunthi and Ira

are driven to prostitution because of Hunger. Hunger and starvation are the main reasons for degradation of families. Sufferings of Indian farmers are larger than actual characters in the novel. Their heroic activities to hunger inculcate epic dimensions in the novel. The themes of rootless and migration are completely a part of Diaspora reflection and Indian fatalism. Village people are uprooted by industrialisation. Rukmani and her family is forced to leave the village. She seeks shelter in city. This restlessness cannot bear by Rukmani's husband. His mind is disturbed and scattered. They travel together by a bullock-cart to the city at a distance of hundred miles. Their journey symbolises Diaspora journey of other poor villages. The Indian culture and spirituality has a deep faith in social strength and power. Passive acceptance is the Indian way of life. We are surprised to see their will-power and endurance through extremes of poverty, hunger and misery. They cannot adjust their life with modern sophisticated society.

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Corona Virus Disease: The Empirical Virtues and Struggles of Medical Practitioners in India During the Pandemic

Hima Harry, Assistant Professor on Contract, Department of English, Carmel College Mala, Thrissur (Dist.), Kerala, India

Abstract: This study tends to focus on two important aspects of the Medical Practitioners in India. The first section of this study analyses about the role and *Empirical virtues* of the Medical Practitioners. The second section of the study interprets various *struggles of Medical Practitioners* in social, sexual and economical aspects. It can be seen as a specific way of discussions about the various virtues and attitudes of the Medical Practitioners among the hearts of COVID 19 patients. This discussion promotes to shed lights on the lives of all Medical Practitioners during the pandemic.

Keywords: Empirical virtues, Administrative injustices, Sexual abuses, Economical exploitations and Social Inequalities

India is a developing country. India's primarily health care system is controlled by all states during the outbreak of COVID19. India has followed a multiple health system including public and private health care services. Our Indian states are adopted Preventive and Curative health care systems for COVID 19. These attempts are done to ensure to access the primary care to the entire humanity. They are promoting qualitative health care services also.

Indian government maintains human health by undertaking enumerative measures like medical education, quality control in the production of drugs and quarantine facility for COVID 19 patients. Indian Hospitals have the best expertise Medical practitioners and Infrastructure facilities now. India focuses on an exploration of quality maintenance and care-taking programmes for COVID 19 victims.

The Health Ministry is announced that India's COVID 19 recovery rate is higher than the mortality rate. It is possible only because of the hardest tasks committed by these Medical Practitioners. Medical Practitioners in India involve high levels of skills and long training practices. They are trained in all specific fields of medicines and medical procedures

Who is a Medical Practitioner?

A Medical Practitioner is one who promotes health care systems for the safety of the common people. These Medical Practitioners are a group of persons worked as doctors, nurses, technicians and clerical staff. Those persons are absolutely connected with different spectrums of the entire society. They are facing many struggles with their personal and impersonal life. We cannot ignore the enormous strength undertaken by them. Courage, Self-awareness, Mental strength and wholeheartedness are the essential qualities for a Medical Practitioner during the pandemic. A Medical Practitioner is one who never fails in his attempts. He is completely acted as the saviour of the patients. His genuine character and reliable nature is the source of energy for the common people. These unique qualities of Medical Practitioners make the life of patients more fruitful.

A patient attains his improvement by the observation and appreciation of a Medical Practitioner. Now Medical Practitioners are whole-heartedly dedicated their lives for COVID 19 patients. These admirable character traits of Medical Practitioners become the optimistic sign for the COVID 19 patients. They are taking their responsibilities for their own actions.

Medical Practitioners are developing honest relationships with their patients. They do their works tirelessly to protect the life of the Corona Virus patients. They are trying to achieve the needs of the patients irrespective of caste, colour, and social status difference. They are undoubtedly kept the patient's dignity throughout their treatments.

What are the Empirical Virtues of a Medical Practitioner?

The Empirical Virtues of the Medical Practitioners demand the great strengths relating to their services. During the outbreak of COVID 19, Medical Practitioners content themselves without thinking about their internal struggles. Their hearts are filled with the noble values of compassion, love, caring and understanding towards COVID 19 patients. These virtues and attitudes enable them to pursue their hopes they have adopted.

Medical Practitioners are always opened their hearts to receive their alternative arrangements. They are flexible in their characters. They develop a feeling of trust and Security among COVID 19 patients. They are true supporters of the hospitals to attain their missions and values. They are considered as the builders. They are making their service platforms more pleasant for every patient.

Medical Practitioners perform a wide range of duties and responsibilities to their patients. They are obligated to observe and practice their ethical standards in their duties. They have to face a range of challenges and their misbehaviours. They have a moral duty to supervise their patients. They are acted as the saviours of the patients.





'Life' is the precious stone of everybody's life. Our Medical Practitioners are pleasantly ready to sacrifice their own lives for the victims of COVID19. Freedom of expression and opportunity is the foundation for all other freedoms. Medical Practitioners lack their freedoms to live happily with their families. But they are not arguing about their lack of liberty. Medical practitioners satisfy and fulfil all needs of the patients. Their lives make contribution to the entire humanity. They create a culture of their own in which all COVID 19 patients are proud of their services and want to become succeed in their missions. COVID 19 patients regularly advised and secured by the positive criticism from the side of Medical Practitioners which are framed to lead happy improvements in their health. They are fostering great results in their attempts.

Conclusion

Medical Practitioners are creating a right environment for the improvement of their patients. Their minds are structured with their personal traits. Their communication skills, work ethics, technical competency, flexibility, determination and ability to work in harmony with co-workers are appreciable. All Medical Practitioners are working tirelessly to protect and save the life their patients irrespective of these struggles in their life. So it is our duty to express a great thanks to them during the pandemic. Their responsibilities can provide acute treatments to these victims. Medical Practitioners are providing their core values of their profession directly with patients, families and communities. This study is an attempt to conceptualize empirical virtues and struggles of Medical Practitioners during the pandemic.

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models of this pandemic. They are restarting life in the COVID 19 era. Medical Practitioners identify and maintain good working relationships with COVID 19 patients.

Medical Practitioners can easily make a good rapport with the victims. Good planning and overseeing nature of them help to develop confidence and power among the minds of patients. The Empirical Virtues typically demand Medical Practitioners to show their respects for all patients. They are the gems of Indian society.

What are the Struggles and Challenges?

Our country shows more advances in medicine, science, technology and training. Medical Practitioners in India are facing innumerable challenges in their life. Economical, Social, personal and sexual disputes are directly and indirectly faced by them. Their medical challenges include long working hours, short staffing and working place violence. Nurses and doctors are playing integral roles in our healthcare industry. Their inclusion of various measures in COVID 19 patients are overwhelming efforts.

The administrative systems of the Hospitals in India are not gratified. The unorganized and Unsystematic administrative systems of the Hospitals make the staff to develop a *Sense of Insecurity* in their life. Limited availabilities of the masks, safety dresses and other essential Precautions force the Medical Practitioners to leave their duties.

The Economical struggle is the most crucial problem faced by Medical Practitioners in India. Most of them are maltreated economically and physically. Their economical discontentment leads to them in a poverty life. They cannot meet their financial needs. Their financial harassments are completely hurt to their minds during the pandemic. The lowest salary systems and the sudden outbreak of the virus completely betray their life.

Social factors of the Medical Practitioners are not appeasing. 'Social-Distancing' is the best precaution for COVID 19 now. This is cannot be practicable for the case of our vibrant Medical Practitioners. But common people are not ready to realize the 'Herculean Tasks' undertaken by these practitioners. People are misjudged them as "*Carriers of COVID19* disease. People are not behaving properly to them. Thus undoubtedly they completely isolated by society, neighbours and friends.

Family and friends are great treasures for our Medical Practitioners .They is closely bounded relationships with family. They are serving COVID 19 patients by ignoring their affection towards children, parents and life-partners. But most of the families are not trying to make out the helping nature cooperation of these Medical Practitioners. Harsh treatments and uncooperative behaviour patterns of the family members force them to lead a life of loneliness and desperation. In reality, fifty percentages of Medical Practitioners say that juggling work with personal lives is the most stressful part of their job.

Sexual Abuses are other emerging troubles meet by them. Female doctors, nurses and other staff are mistreated and sexually exploited during this pandemic by their authorities and co-workers. They lose their powers of voices against these sexual inequalities. They are treated as the real preys under the hands of the sexual hunters. Finally, they will become the victims of the present society.

'Life' is the precious stone of everybody's life. Our Medical Practitioners are pleasantly ready to sacrifice their own lives for the victims of COVID19. Freedom of expression and opportunity is the foundation for all other freedoms. Medical Practitioners lack their freedoms to live happily with their families. But they are not arguing about their lack of liberty. Medical practitioners satisfy and fulfil all needs of the patients. Their lives make contribution to the entire humanity .They create a culture of their own in which all COVID 19 patients are proud of their services and want to become succeed in their missions. COVID 19 patients regularly advised and secured by the positive criticism from the side of Medical Practitioners which are framed to lead happy improvements in their health. They are fostering great results in their attempts.

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Christophe Chesneau, Lishamol Tomy & Meenu Jose

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Wrapped modified Lindley distribution

Christophe Chesneau*
Department of Mathematics
Université de Caen
LMNO
Campus II
Science 3
Caen 14032
France

Lishamol Tomy[†]
Department of Statistics
Deva Matha College
Kuravilangad 686633
Kerala
India

Meenu Jose[§]
Department of Statistics
Carmel College, Mala
Thrissur 680732
Kerala
India

Abstract

To model data in angular form, circular distributions are the most appropriate mathematical tools. In this paper, we introduce a new one-parameter circular distribution based on the wrapping method, called the wrapped modified Lindley distribution. Characteristic function and fundamental properties of this distribution are described. Method of maximum likelihood estimation is used for the estimation of the parameter. The proposed model is applied to two real-life datasets, and its performance is compared with

*E-mail: christophe.chesneau@gmail.com (Corresponding Autor)

[†]E-mail: lishatomy@gmail.com

[§]E-mail: meenusgc@gmail.com

that of the wrapped Lindley, wrapped exponential and transmuted wrapped exponential models.

Subject Classification: 60E05, 62E15, 62F10.

Keywords: Modified Lindley distribution, Wrapped Lindley distribution, Trigonometric moments, Characteristic function, Method of maximum likelihood, Data analysis.

1. Introduction

When the data points are distributed on a circle instead of the real line (or part of it), the related phenomenon can be not modeled by a random variable having standard distributions, motivating the emergence of the so-called circular distributions. In contemporary scenarios, the use of circular distributions has been relevant in various circumstances like astronomy, demography, image analysis, geology, meteorology and earth science. For this reason, numerous researchers develop circular distributions with various features, aiming to extend the scope of applications in this setting. Here, arises the scope of study of circular data by using circular models.

As prime definition, a circular distribution is a probability distribution whose total probability is concentrated on an unit circle in the plane, i.e., $\{(\cos(\theta), \sin(\theta)); \theta \in [0, 2\pi)\}$. Wrapping is one of the methods to create a circular distribution. If X is a random variable defined on a real line, then the corresponding wrapped random variable θ is defined as $\theta = X \pmod{2\pi}$. This method creates a wide class of probability distributions that are flexible to accommodate the different characteristics of circular data. In particular, Levy (1939) proposed wrapped distributions which laid the first stone of this method. Several authors have done extensive works on introducing wrapped distributions and studying their statistical properties and inference procedures. We refer the reader to the wrapped Laplace distribution by Jammalamadaka and Kozubowski (2003), wrapped exponential distribution by Jammalamadaka and Kozubowski (2004), wrapped t family circular distribution by Pewsey *et al.* (2007), wrapped gamma distribution by Coelho (2007), wrapped stable family of distributions by Pewsey (2008), wrapped three-parameter gamma distribution by Roy and Adnan (2010), wrapped chi-square distribution by Adnan and Roy (2011), wrapped weighted exponential distribution by Roy and Adnan (2012), wrapped generalized Gompertz distribution by Roy and Adnan (2012), wrapped geometric distribution by Jacob and Jayakumar (2013) and wrapped variance gamma distribution by Adnan and Roy (2014). Recently, Joshi and Jose (2017) proposed a new

circular distribution by wrapping the Lindley distribution and applied it for biological data. Also, Yilmaz and Bicer (2018) derived transmuted wrapped exponential distribution and studied its properties.

In the last decades, the Lindley distribution and its generalizations have been widely used by different authors. In this regard, we may refer the interested reader to Singh et al. (2016), Elgarhy et al. (2018) and Tomy (2018), and the references therein. As a recent development, Chesneau et al. (2019) derived the modified Lindley distribution, constituting a one-parameter lifetime distribution halfway between the exponential and Lindley distributions with desirable modelling properties. On the other side, circular models that can be generated by wrapping known distributions have wide applications in the present scenario. In this article, we adapt the modified Lindley distribution in view of analyzing circular data by wrapping the modified Lindley probability density function around the circumference of a unit circle. The resulting distribution is called the wrapped modified Lindley distribution. We explore the theoretical and practical properties of this new wrapped distribution. In particular, we show that, in some situations, the wrapped modified Lindley distribution provides a serious alternative to modern distributions using the wrapping technique, such as the transmuted wrapped exponential, wrapped exponential and wrapped Lindley distributions.

The rest of the paper is organized as follows. In Section 2, we introduce the wrapped modified Lindley distribution and, in Section 3, we discuss its different properties, including the trigonometric moments. The maximum likelihood estimator of the unknown parameter is described in Section 4. In Section 5, the analysis of two real data set is presented, illustrating the modeling potential of the wrapped modified Lindley distribution. Finally, the conclusion of the paper appears in Section 6.

2. The wrapped modified Lindley distribution

Recently, Chesneau et al. (2019) proposed a new general family of modified Lindley distributions. It is defined by a cumulative density function (cdf) which is a particular weighted modification of the cdf of the Lindley distribution. The modified Lindley (ML) distribution is a special member of this family, defined with a particular weighted exponential function, making it halfway between the exponential and Lindley distributions. More precisely, the ML distribution with parameter $\lambda > 0$ is characterized by

$$F(x) = 1 - \left[1 + \frac{\lambda x}{1 + \lambda} e^{-\lambda x} \right] e^{-\lambda x}; \quad x > 0. \quad (1)$$

By differentiation of $F(x)$, the corresponding probability density function (pdf) is given by

$$f(x) = \frac{\lambda}{1 + \lambda} e^{-2\lambda x} \left[(1 + \lambda)e^{\lambda x} + 2\lambda x - 1 \right]; \quad x > 0, \lambda > 0.$$

An important remark is that we can write $f(x)$ as

$$f(x) = f_1(x) + a(f_2(x) - f_3(x)), \quad (2)$$

where $f_1(x)$ is the pdf of the exponential distribution with parameter λ , i.e., $f_1(x) = \lambda e^{-\lambda x}$, $x > 0$, $f_2(x)$ is the pdf of the gamma distribution with parameters $(2, 2\lambda)$, i.e., $f_2(x) = (2\lambda)^2 x e^{-2\lambda x}$, $x > 0$, $f_3(x)$ is the pdf of the exponential distribution with parameter 2λ , i.e., $f_3(x) = 2\lambda e^{-2\lambda x}$, $x > 0$, and $a = 1/[2(1 + \lambda)] \in (0, 1/2)$.

Now, we propose a circular (wrapped) form of the ML distribution. Let X be a random variable following the ML distribution with parameter λ . Then, the wrapped modified Lindley (WML) distribution is defined by the one of $\theta = X \pmod{2\pi}$. The random variable θ having the WML distribution is denoted by $\theta \sim \text{WML}(\lambda)$. The rest of this section is devoted to the main functions related to the WML distribution, i.e., its pdf and cdf, with some plots as illustration.

The result above presents the corresponding pdf of the WML distribution.

Proposition 2.1 : The pdf of $\theta \sim \text{WML}(\lambda)$ is given by

$$g(\theta) = \frac{\lambda e^{-\lambda\theta}}{1 - e^{-4\lambda\pi}} \left\{ 1 + e^{-2\lambda\pi} + \frac{e^{-\lambda\theta}}{1 + \lambda} \left[2\lambda\theta - 1 + \frac{4\lambda\pi e^{-4\lambda\pi}}{1 - e^{-4\lambda\pi}} \right] \right\}; \quad (3)$$

$$\lambda > 0, \theta \in [0, 2\pi).$$

Proof : As alpha definition, based on (2), the pdf of $\theta \sim \text{WML}(\lambda)$ is given by

$$g(\theta) = \sum_{m=0}^{+\infty} f(\theta + 2m\pi) = \sum_{m=0}^{+\infty} f_1(\theta + 2m\pi) + a \left[\sum_{m=0}^{+\infty} f_2(\theta + 2m\pi) - \sum_{m=0}^{+\infty} f_3(\theta + 2m\pi) \right].$$

Now, remark that, after some algebra,

$$\begin{aligned}\sum_{m=0}^{+\infty} f_1(\theta + 2m\pi) &= \lambda e^{-\lambda\theta} \sum_{m=0}^{+\infty} e^{-2m\lambda\pi} = \frac{\lambda e^{-\lambda\theta}}{1 - e^{-2\lambda\pi}}, \\ \sum_{m=0}^{+\infty} f_2(\theta + 2m\pi) &= (2\lambda)^2 e^{-2\lambda\theta} \sum_{m=0}^{+\infty} (\theta + 2m\pi) e^{-4m\lambda\pi} \\ &= (2\lambda)^2 e^{-2\lambda\theta} \left[\frac{\theta}{1 - e^{-4\lambda\pi}} + \frac{2\pi e^{-4\lambda\pi}}{(1 - e^{-4\lambda\pi})^2} \right]\end{aligned}$$

and

$$\sum_{m=0}^{+\infty} f_3(\theta + 2m\pi) = 2\lambda e^{-2\lambda\theta} \sum_{m=0}^{+\infty} e^{-4m\lambda\pi} = \frac{2\lambda e^{-2\lambda\theta}}{1 - e^{-4\lambda\pi}}.$$

Therefore, by putting the above equalities together, we obtain

$$\begin{aligned}g(\theta) &= \sum_{m=0}^{+\infty} f(\theta + 2m\pi) \\ &= \frac{\lambda e^{-\lambda\theta}}{1 - e^{-2\lambda\pi}} + \frac{1}{2(1 + \lambda)} \left[(2\lambda)^2 e^{-2\lambda\theta} \left(\frac{\theta}{1 - e^{-4\lambda\pi}} + \frac{2\pi e^{-4\lambda\pi}}{(1 - e^{-4\lambda\pi})^2} \right) - \frac{2\lambda e^{-2\lambda\theta}}{1 - e^{-4\lambda\pi}} \right] \\ &= \frac{\lambda e^{-\lambda\theta}}{1 - e^{-2\lambda\pi}} + \frac{\lambda e^{-2\lambda\theta}}{1 + \lambda} \left[\frac{2\lambda\theta - 1}{1 - e^{-4\lambda\pi}} + \frac{4\lambda\pi e^{-4\lambda\pi}}{(1 - e^{-4\lambda\pi})^2} \right] \\ &= \frac{\lambda e^{-\lambda\theta}}{1 - e^{-4\lambda\pi}} \left\{ 1 + e^{-2\lambda\pi} + \frac{e^{-\lambda\theta}}{1 + \lambda} \left[2\lambda\theta - 1 + \frac{4\lambda\pi e^{-4\lambda\pi}}{1 - e^{-4\lambda\pi}} \right] \right\}.\end{aligned}$$

This ends the proof of Proposition 2.1. \square

Remark 2.2: We can write the pdf $g(\theta)$ as a linear combination of wrapped exponential and wrapped gamma pdfs as

$$g(\theta) = g_1(\theta) + a(g_2(\theta) - g_3(\theta)),$$

where $g_1(\theta)$ is the pdf of the wrapped exponential distribution with parameter λ , i.e., $g_1(\theta) = \lambda e^{-\lambda\theta} / (1 - e^{-2\lambda\pi})$, $\theta \in [0, 2\pi)$, $g_2(\theta)$ is the pdf of the wrapped gamma distribution with parameters $(2, 2\lambda)$, i.e., $g_2(\theta) = (2\lambda)^2 e^{-2\lambda\theta} [\theta / (1 - e^{-4\lambda\pi}) + 2\pi e^{-4\lambda\pi} / (1 - e^{-4\lambda\pi})^2]$, $\theta \in [0, 2\pi)$, $g_3(\theta)$ is the pdf of the wrapped exponential distribution with parameter 2λ , i.e., $g_3(\theta) = 2\lambda e^{-2\lambda\theta} / (1 - e^{-4\lambda\pi})$, $\theta \in [0, 2\pi)$, and $a = 1 / [2(1 + \lambda)]$. This representation will be useful to determine the fundamental properties of the WML distribution.

The cdf of $\theta \sim \text{WML}(\lambda)$ is obtained as follows, after some algebra similar to those in the proof of Proposition 2.1,

$$\begin{aligned}
 G(\theta) &= \sum_{m=0}^{+\infty} [F(\theta + 2m\pi) - F(2m\pi)] \\
 &= \sum_{m=0}^{+\infty} \left(\left[1 + \frac{2m\lambda\pi}{1+\lambda} e^{-2m\lambda\pi} \right] e^{-2m\lambda\pi} - \left[1 + \frac{\lambda(\theta + 2m\pi)}{1+\lambda} e^{-\lambda(\theta + 2m\pi)} \right] e^{-\lambda(\theta + 2m\pi)} \right) \\
 &= (1 - e^{-\lambda\theta}) \frac{1}{1 - e^{-2\lambda\pi}} + \frac{2\lambda\pi}{1+\lambda} (1 - e^{-2\lambda\theta}) e^{-4\lambda\pi} \frac{1}{(1 - e^{-4\lambda\pi})^2} \\
 &\quad - \frac{\lambda\theta}{1+\lambda} e^{-2\lambda\theta} \frac{1}{1 - e^{-4\lambda\pi}}. \tag{4}
 \end{aligned}$$

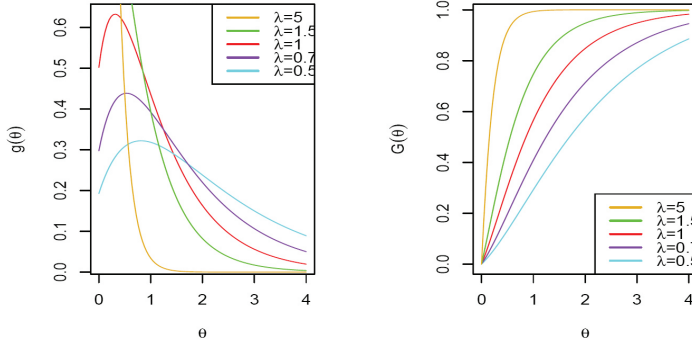


Figure 1

Pdf and cdf of the WML distribution for various values of λ .

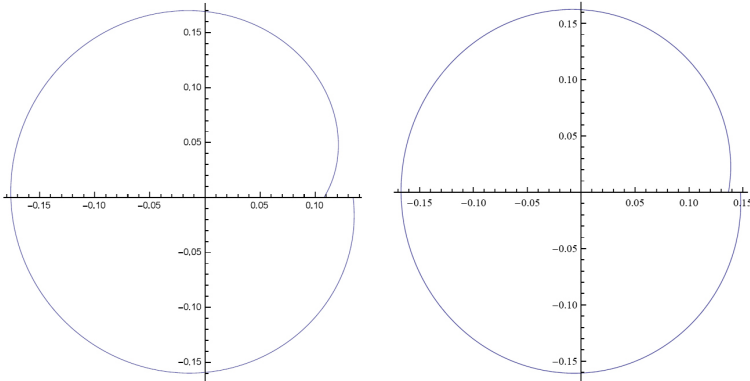


Figure 2

Circular representation of the pdf of the WML distribution for $\lambda = 0.15$ and $\lambda = 0.1$, respectively.

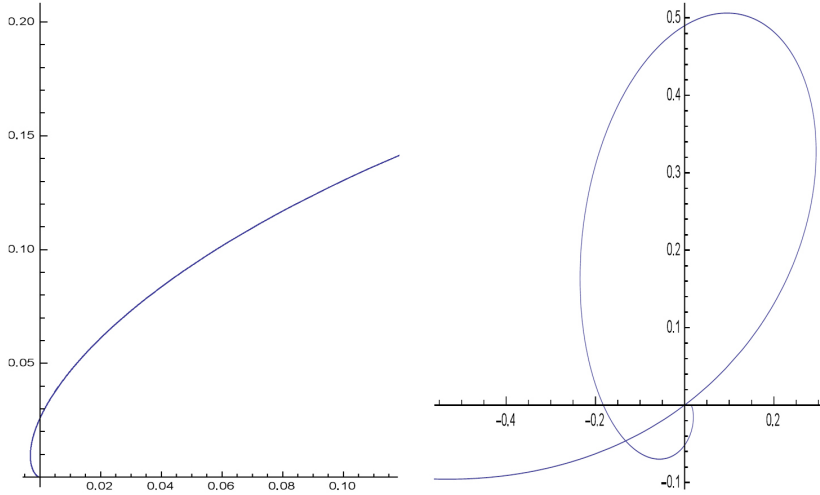


Figure 3

Circular representation of the pdf of the WML distribution for $\lambda = 3$ and $\lambda = 0.65$, respectively.

Figure 1 depicts the behavior of the pdf and cdf of the proposed distribution for different values of λ . The plots indicate that the WML distribution can be reverse J-shaped and left-skewed. Also, the circular presentations of the WML pdf for different parameter values are shown in Figures 2 and 3.

3. Fundamental properties

Here, we present some fundamental properties of the WML distribution, starting with its characteristic function. First of all, by denoting \mathbb{E} the expectation and i the unit imaginary number, let us recall that the characteristic function of the ML distribution is given by

$$\varphi(t) = \mathbb{E}(e^{itX}) = \frac{\lambda}{\lambda - it} + \frac{it\lambda}{(1 + \lambda)(2\lambda - it)^2}; \quad t \in \mathbb{R}.$$

After some algebra, we get

$$\varphi(t) = \frac{\lambda^2}{\lambda^2 + t^2} - \frac{4\lambda^2 t^2}{(1 + \lambda)(4\lambda^2 + t^2)^2}$$

$$+i \left[\frac{\lambda t}{\lambda^2 + t^2} + \frac{4\lambda^3 t}{(1+\lambda)(4\lambda^2 + t^2)^2} - \frac{\lambda t^3}{(1+\lambda)(4\lambda^2 + t^2)^2} \right].$$

For $p = \pm 1, \pm 2, \dots$, the p^{th} trigonometric moment of θ is given by

$$\varphi_p = \varphi(p) = \alpha_p + i\beta_p,$$

where α_p and β_p are the p^{th} non-central trigonometric moments of the respective distribution

$$\begin{aligned} \alpha_p &= \frac{\lambda^2}{\lambda^2 + p^2} - \frac{4\lambda^2 p^2}{(1+\lambda)(4\lambda^2 + p^2)^2} \\ &= \frac{\lambda^2(16\lambda^5 + 16\lambda^4 + 8\lambda^3 p^2 + 4\lambda^2 p^2 + \lambda p^4 - 3p^4)}{(1+\lambda)(\lambda^2 + p^2)(4\lambda^2 + p^2)^2} \end{aligned}$$

and

$$\begin{aligned} \beta_p &= \frac{\lambda p}{\lambda^2 + p^2} + \frac{4\lambda^3 p}{(1+\lambda)(4\lambda^2 + p^2)^2} - \frac{\lambda p^3}{(1+\lambda)(4\lambda^2 + p^2)^2} \\ &= \frac{\lambda^2 p(16\lambda^4 + 20\lambda^3 + 8\lambda^2 p^2 + 11\lambda p^2 + p^4)}{(1+\lambda)(\lambda^2 + p^2)(4\lambda^2 + p^2)^2}. \end{aligned}$$

One can remark that $\beta_p \geq 0$. Also, by analogy, note that $\alpha_p = \mathbb{E}(\cos(p\theta))$ and $\beta_p = \mathbb{E}(\sin(p\theta))$, which are the p^{th} cosine and sine moment of θ , respectively.

For $p = \pm 1, \pm 2, \dots$, the p -th trigonometric moment of θ is given by

$$\varphi_p = \rho_p e^{i\mu_p},$$

where

$$\rho_p = \sqrt{\alpha_p^2 + \beta_p^2}$$

and, since $\beta_p \geq 0$,

$$\mu_p = \arg(\varphi_p) = \begin{cases} \arctan\left(\frac{\beta_p}{\alpha_p}\right) + \pi & \text{if } \alpha_p < 0, \beta_p \geq 0, \\ \frac{\pi}{2} & \text{if } \alpha_p < 0, \beta_p > 0, \\ \arctan\left(\frac{\beta_p}{\alpha_p}\right) & \text{if } \alpha_p > 0, \\ \text{undefined} & \text{if } \alpha_p = 0, \beta_p = 0, \end{cases} \quad (5)$$

After some algebra, we can express μ_p as (5) with the ratio

$$\frac{\beta_p}{\alpha_p} = p \frac{16\lambda^4 + 20\lambda^3 + 8\lambda^2 p^2 + 11\lambda p^2 + p^4}{16\lambda^5 + 16\lambda^4 + 8\lambda^3 p^2 + 4\lambda^2 p^2 + \lambda p^4 - 3p^4}$$

and

$$\rho_p = \lambda^2 \sqrt{\frac{16\lambda^4 + 32\lambda^3 + 8\lambda^2 p^2 + 16\lambda^2 + 16\lambda p^2 + p^4 + 9p^2}{(1+\lambda)^2(\lambda^2 + p^2)(4\lambda^2 + p^2)^2}}.$$

The mean direction of θ is given by μ_1 . The angular concentration of θ is obtained as

$$\rho_1 = \lambda^2 \sqrt{\frac{16\lambda^4 + 32\lambda^3 + 24\lambda^2 + 16\lambda + 10}{(1+\lambda)^2(\lambda^2 + 1)(4\lambda^2 + 1)^2}}.$$

The circular variance of θ is

$$V = 1 - \rho_1 = 1 - \lambda^2 \sqrt{\frac{16\lambda^4 + 32\lambda^3 + 24\lambda^2 + 16\lambda + 10}{(1+\lambda)^2(\lambda^2 + 1)(4\lambda^2 + 1)^2}}.$$

The circular standard deviation of θ is obtained as

$$\sigma = \sqrt{-2\log(\rho_1)} = \sqrt{-4\log(\lambda) - \log\left(\frac{16\lambda^4 + 32\lambda^3 + 24\lambda^2 + 16\lambda + 10}{(1+\lambda)^2(\lambda^2 + 1)(4\lambda^2 + 1)^2}\right)}.$$

The p -th central cosine and sine moment of θ are given by, respectively,

$$\bar{\alpha}_p = \mathbb{E}[\cos(p(\theta - \mu_1))], \quad \bar{\beta}_p = \mathbb{E}[\sin(p(\theta - \mu_1))].$$

By using standard trigonometric formula, we can express them as

$$\bar{\alpha}_p = \beta_p \sin(p\mu_1) + \alpha_p \cos(p\mu_1) \quad \text{and} \quad \bar{\beta}_p = \beta_p \cos(p\mu_1) - \alpha_p \sin(p\mu_1).$$

The skewness and kurtosis coefficients of θ are given by, respectively,

$$\gamma_1 = \frac{\bar{\beta}_2}{V^{3/2}}, \quad \gamma_2 = \frac{\bar{\alpha}_2 - \rho_1^4}{V^2}.$$

Table 1 exhibits the numerical values of different characteristics of the WML distribution for various values of the parameter λ . It can be seen that, when λ increases, the circular variance decreases. Similarly, the coefficient of skewness decreases when λ increases. On the other hand, when λ increases, the coefficient of kurtosis increases.

Table 1
Numerical values of different characteristics of the WML distribution for various values of λ .

Characteristics of the WML distribution		$\lambda = 0.25$	$\lambda = 1$	$\lambda = 1.5$	$\lambda = 2$	$\lambda = 5$
Trigonometric moments	α_1	-0.0692	0.42	0.6563	0.7815	0.9599
	α_2	-0.0289	0.075	0.2748	0.4467	0.8559
	β_1	0.1393	0.56	0.5096	0.4346	0.2004
	β_2	0.0400	0.4	0.5155	0.54	0.3596
Circular variance	V	0.8445	0.3	0.1691	0.1057	0.0194
Circular standard deviation	σ	1.9292	0.8446	0.6087	0.4728	0.1979
Mean direction	μ_1	2.0317	0.9273	0.6602	0.5075	0.2058
Central trigonometric moments	$\bar{\alpha}_1$	0.1555	0.7	0.8309	0.892	0.9806
	$\bar{\alpha}_2$	-0.0144	363	0.5675	0.6944	0.9282
	$\bar{\beta}_1$	3.469447e-17	5.511e-17	-5.511e-17	0	2.7755e-17
	$\bar{\beta}_2$	-0.0472	-0.184	-0.1384	-0.0945	-0.0128
Coefficient of skewness	γ_1	-0.0608	-1.1198	-1.9907	-2.7487	-4.75890
Coefficient of kurtosis	γ_2	-0.0210	1.3655	3.1789	4.9080	9.7514

4. Maximum likelihood method

In this section, the WML model is considered and we investigate the estimation of λ by the method of maximum likelihood. Let $\theta_1, \theta_2, \dots, \theta_n$ be n independent realizations from the WML distribution. Then, the corresponding likelihood function is given by

$$L(\lambda) = \prod_{i=1}^n g(\theta_i) = \frac{\lambda^n}{(1 - e^{-4\lambda\pi})^n} e^{-\lambda \sum_{i=1}^n \theta_i} \prod_{i=1}^n \left\{ 1 + e^{-2\lambda\pi} + \frac{e^{-\lambda\theta_i}}{1 + \lambda} \left[2\lambda\theta_i - 1 + \frac{4\lambda\pi}{e^{4\lambda\pi} - 1} \right] \right\}$$

and the corresponding log-likelihood function is obtained as

$$\begin{aligned} \ell(\lambda) &= \log[L(\lambda)] \\ &= n \log(\lambda) - n \log(1 - e^{-4\lambda\pi}) - \lambda \sum_{i=1}^n \theta_i + \sum_{i=1}^n \log \left\{ 1 + e^{-2\lambda\pi} + \frac{e^{-\lambda\theta_i}}{1 + \lambda} \left[2\lambda\theta_i - 1 + \frac{4\lambda\pi}{e^{4\lambda\pi} - 1} \right] \right\}. \end{aligned}$$

The maximum likelihood estimator is obtained by the maximization of $\ell(\lambda)$ with respect to λ . Here, we can obtain it by solving the equation $\partial\ell(\lambda)/\partial\lambda = 0$, i.e.,

$$\frac{n}{\lambda} - n \frac{4\pi}{e^{4\pi\lambda} - 1} - \sum_{i=1}^n \theta_i + \sum_{i=1}^n \frac{h(\theta_i; \lambda)}{1 + e^{-2\lambda\pi} + \frac{e^{-\lambda\theta_i}}{1 + \lambda} \left[2\lambda\theta_i - 1 + \frac{4\lambda\pi}{e^{4\lambda\pi} - 1} \right]} = 0,$$

where

$$\begin{aligned} h(\theta_i; \lambda) &= -\frac{2\lambda\theta_i^2 e^{-\lambda\theta_i}}{1 + \lambda} + \frac{3\theta_i e^{-\lambda\theta_i}}{1 + \lambda} - \frac{2\lambda\theta_i e^{-\lambda\theta_i}}{(1 + \lambda)^2} - \frac{4\pi\lambda\theta_i e^{-\lambda\theta_i}}{(e^{4\pi\lambda} - 1)(1 + \lambda)} + \frac{e^{-\lambda\theta_i}}{(1 + \lambda)^2} \\ &\quad - \frac{16\pi^2 \lambda e^{4\pi\lambda} e^{-\lambda\theta_i}}{(e^{4\pi\lambda} - 1)^2 (1 + \lambda)} + \frac{4\pi e^{-\lambda\theta_i}}{(e^{4\pi\lambda} - 1)(1 + \lambda)} - \frac{4\pi\lambda e^{-\lambda\theta_i}}{(e^{4\pi\lambda} - 1)(1 + \lambda)^2} - 2\pi e^{-2\pi\lambda}. \end{aligned}$$

The equation above cannot be solved analytically. Thus, different numerical techniques can be performed to get a solution, by the use of any mathematical software (R, Python, Matlab, Mathematica...).

5. Applications

In this section, we illustrate the usefulness of the WML model. We fit the WML distribution to two practical data sets and compare the results with those of the fitted wrapped Lindley (WL), wrapped exponential (WE) and transmuted wrapped exponential (TWE) distributions. We estimate the unknown parameter(s) of each model by the maximum likelihood method. Also, the statistics Akaike information criterion (AIC) and Bayesian information criterion (BIC) are used to compare the four models. We recall that $AIC = 2k - 2l$ and $BIC = k \log(n) - 2l$, where k is the number of parameters, n is the sample size and l is the maximized value of the log-likelihood function under the considered model.

Table 2
Estimated values, log-likelihood, AIC and BIC for the turtle data set

Distribution	Estimates	l	AIC	BIC
WML	$\hat{\lambda} = 0.5605278$	-118.2947	238.5895	240.9202
WL	$\hat{\lambda} = 0.7845654$	-119.805	241.6101	243.9408
WE	$\hat{\lambda} = 0.4228703$	-120.6474	243.2939	245.6256
TWE	$\hat{\lambda} = 0.7476771$ $\hat{\Lambda} = -0.9515879$	-117.9474	239.8949	244.5564

5.1 The turtle data set

The turtle data set was given by Rao and Sen Gupta (2001). It contains orientations of 76 turtles laying their eggs. This data set is also considered in Joshi and Jose (2017) with the WL distribution as contribution. The data are as given below.

{8, 9, 13, 13, 14, 18, 22, 27, 30, 34, 38, 38, 40, 44, 45, 47, 48, 48, 48, 48, 50, 53, 56, 57, 58, 58, 61, 63, 64, 64, 64, 65, 65, 68, 70, 73, 78, 78, 78, 83, 83, 88, 88, 88, 90, 92, 92, 93, 95, 96, 98, 100, 103, 106, 113, 118, 138, 153, 153, 155, 204, 215, 223, 226, 237, 238, 243, 244, 250, 251, 257, 268, 285, 319, 343, 350}.

Table 2 gives the relevant numerical summaries for the four fits based on the turtle data set.

Figure 4 gives the graph of estimated pdf and cdf of the considered distributions for the turtle data set.

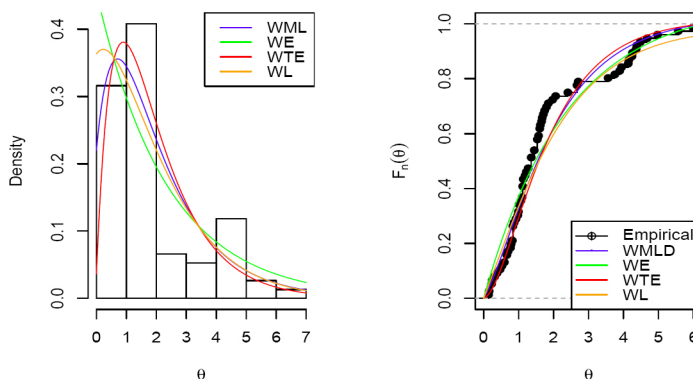


Figure 4

Estimated pdfs and cdfs of the considered distributions for the turtle data set.

Table 3
Estimated values, log-likelihood, AIC and BIC for the feldspar laths data set.

Distribution	Estimates	l	AIC	BIC
WML	$\hat{\lambda} = 0.7131918$	-175.7633	353.5265	356.4093
WL	$\hat{\lambda} = 0.9713978$	-176.87271	355.7454	357.6575
WE	$\hat{\lambda} = 0.61212855$	-182.8546	367.7091	370.5919
TWE	$\hat{\lambda} = 0.8836261$ $\hat{\Lambda} = -0.74378339$	-174.5348	353.0696	358.8352

5.2 Long-axis orientations of feldspar laths data

The feldspar laths data set was given by Fisher (1993). It contains the measurements of long-axis orientations of feldspar laths: a data of 133 measurements of feldspar laths in basalt direction in degrees as given below. {176, 162, 49, 174, 174, 49, 54, 63, 59, 61, 66, 104, 97, 58, 121, 5, 178, 3, 168, 0, 18, 39, 140, 63, 55, 170, 169, 37, 152, 73, 53, 176, 72, 170, 113, 56, 87, 161, 164, 21, 50, 6, 59, 140, 54, 64, 56, 38, 61, 143, 51, 144, 148, 44, 60, 98, 86, 145, 38, 168, 39, 134, 68, 57, 129, 68, 132, 82, 54, 119, 131, 50, 93, 160, 127, 124, 65, 108, 52, 61, 86, 37, 132, 83, 163, 58, 144, 29, 80, 172, 144, 138, 10, 45, 137, 11, 145, 103, 69, 124, 54, 121, 139, 111, 153, 13, 5, 5, 107, 104, 39, 133, 36, 63, 4, 21, 51, 30, 52, 90, 143, 13, 50, 109, 12, 170, 5, 14, 91, 132, 121}.

Table 3 gives the relevant numerical values for four fits based on long-axis orientations of the feldspar laths data set.

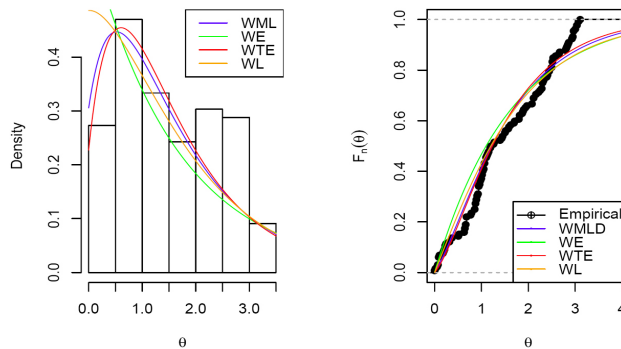


Figure 5
Estimated pdfs and cdfs of the considered distributions for long-axis orientations of the feldspar laths data set.

Figure 5 gives the graph of estimated pdf and cdf of the considered distributions for long-axis orientations of feldspar laths data set.

Thus, in Tables 2 and 3, the maximum likelihood estimates of the parameters for the fitted distributions along with likelihood, AIC and BIC values are presented for two different data sets. Based on the lowest values of the AIC and BIC (excepted the AIC for the TWE model in feldspar laths data set), the WML model turns out to be a better model than the WL, WE and TWE models. A visual comparison of the closeness of the fitted pdfs with the observed histograms of the data and fitted cdfs with empirical cdfs for different data sets are presented in Figures 4 and 5, respectively. These plots indicate that the proposed model provides a closer fit to these data sets.

6. Conclusion

In this article, we used the wrapping method to introduce a new circular distribution, called the WML distribution. A class of basic properties is also found here, including characteristic function, trigonometric moments, circular variance, circular standard deviation, skewness and kurtosis. The maximum likelihood method is employed for estimating the model parameters. Two applications of real life data fitting show good result in favor of the proposed distribution when compared to WL, WE and TWE distributions. Therefore, the proposed distribution may be considered as a good contribution to the existing knowledge.

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Social Exclusion Faced by Elderly Women

Ms. Romio Mulakkal¹*, Dr. Licy AD²

¹Research Scholar, M.G. University, Meghalaya, India

²Head, Dept. of Sociology, Carmel College, Mala, Kerala, India

***Corresponding author**

Ms. Romio Mulakkal

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Abstract: Modern society has overburden feeling of ageing. Our society blessed with long life expectancy for female which becomes a curse due to the inability to incorporate this into modern atmosphere. Kerala is not an exception to this. Objective of this study is the major factors lead elderly to social exclusion. In this context descriptive method was undertaken. Analysis was based on primary and secondary data. Primary data is collected through structured interview schedule. Samples were selected with random sampling method from Thiruvananthapuram district. 100 samples selected from Thiruvananthapuram district, 50 are from home and 50 from old age home. To identify the factors which lead them to social exclusion, researcher asked questions in connection with it. According to their answer they are categorised. Based on the ranks given by the respondents to each factor a ranking analysis was carried out. Through this study researcher understood that the severity of the factors are different among elderly residing in home and old age home. Any one problem alone can acts as a leading factor for elderly to social exclusion. Several factors are together work hard to make an easy entrance to social exclusion. As age increases, the severity of the economic factor decreases among members residing in home and old age home.

Keywords: Elderly, Ageing, Social exclusion.

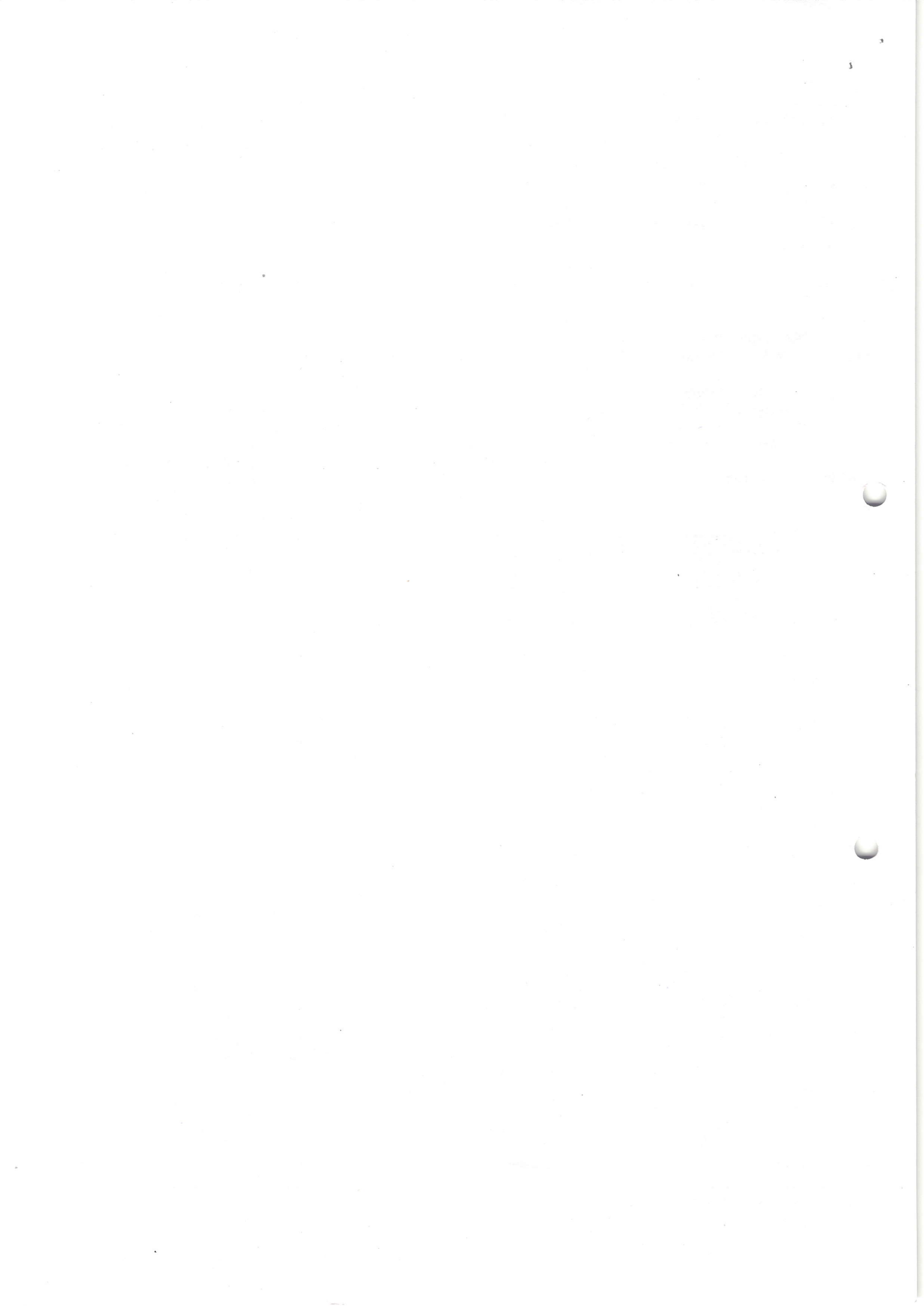
INTRODUCTION

The multidimensional word 'social exclusion', indicates the existing inequalities in society. Social exclusion is the by-product of poverty, unemployment etc. It relates not simply to a lack of material resources, but also to matters like inadequate social participation, lack of cultural and educational capital, inadequate access to services and lack of power. Social exclusion relates to the complexity of powerlessness in modern society. It is the failure of society to provide certain individuals and groups with those rights and benefits normally available to its members, such as employment, adequate housing, health care, education and training etc. In the social world, whether one is heartily welcomed or not is the outcome of collection of social practices. So we can say that social exclusion is the creation of society whether it is appreciable or not. Social exclusion is social disadvantage and relegation to the fringe of society. Whenever our attention focused on elderly population, it throws some light on their alienation in society.

In this computerised era, demographic structure leads to kaleidoscopic changes in society. One of the major issues recognised by demographers is ageing of population. Ageing has become increasingly recognised as an important issue facing individuals, families, communities and nations. Increasing age is

related to long-term health conditions, higher rates of disability and poorer reported health status. As Indian society is based on patriarchal theories, it favours men. In this modern era several initiatives have been taken to bring social inclusion in the society, still women are facing social exclusion in different walks of life, and be it social, political, economic etc. 'Greying population' and 'demographic feminization in ageing' are the two major challenges faced by the twenty first century. Our Society concentrated on the negative impact of these factors. Society's major concentration on negative impact of greying population made elderly population in utter confusion and alienation. In this context descriptive method was undertaken to explore the factors of social exclusion of elderly women. Analysis was based on primary data collected through structured interview schedule. Samples were selected with random sampling method from Thiruvananthapuram ditrict.

Social exclusion in old age is one of the most common issues that are affecting older women constantly. In this industrialised era, social exclusion faced by elderly women is mainly because of the complexity of powerlessness in modern society. Older women, who are still living with their sons/daughters and grand-children are also suffering from emotional exclusion. Due to fast changing socio-economic scenario of the country, fast paced modern life style and



rapid urbanization across the country younger generations hardly interact with their elderly family members. Popularity of nuclear family system has virtually crushed strong traditional bond between grandchildren and grandmothers. Longitudinal explosion of knowledge and transfer of economic authority made this alienation more severely and pathetically.

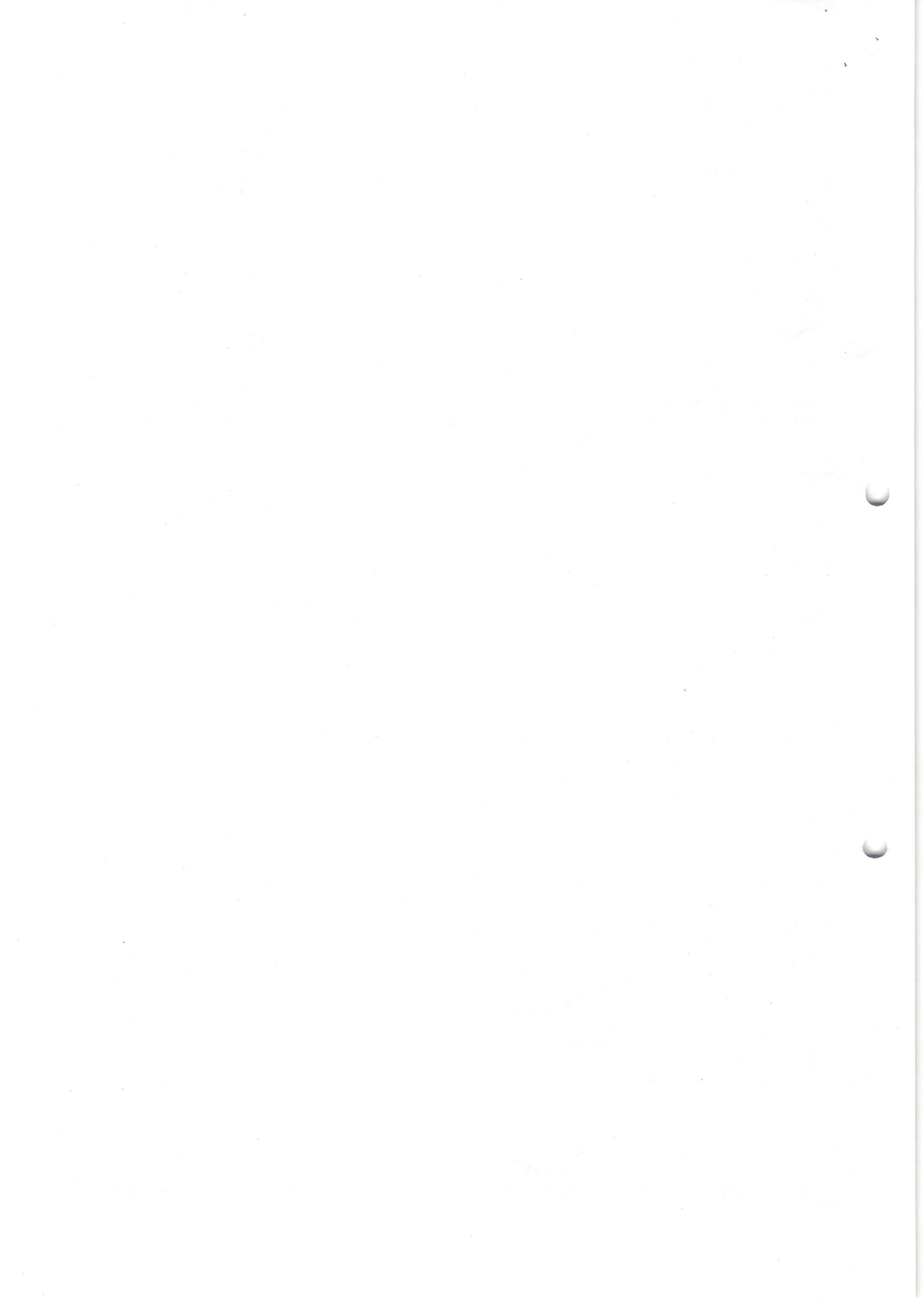
REVIEW OF LITERATURE

A literature review is a text of a scholarly paper, which includes the current knowledge including substantive findings, as well as theoretical and methodological contributions to a particular topic. Literature reviews are a staple for research in nearly every academic field. Literature reviews are used as secondary sources. In the article, "On being old and female: some issues in quality of life of elderly women in India" by Indira Jai Prakash [1] analyses the socio-economic effect of ageing. Though ageing is a universal phenomenon, all aged persons are not alike. Ageing process is different for different persons. This is confirmed in this article. Some of the factors which affect the quality of life are race, gender, social status and marital status. In these, gender is most powerful factor. Due to low social status, poor reproductive health care, economic dependence, malnutrition and domestic violence women's wellbeing is adversely affected. 'Gender ageing' increases the intensity of poverty. In countries like India, with a predominantly patriarchal ethos, older women face triple jeopardy—that of being female, of being old and of being poor. The factors which affect the quality of life of ageing women are marital status, living condition, and health status, socio-economic and political status. Chronic illness increases with age. Older women have more factors with activities of daily living. Probable widowhood is one of the after effects of prolonged life. Widowhood much lowers the socio-economic status of the women. This brings not only loneliness and depression but also economic dependence. Social and political power is achieved by active involvement in public and community life. In general older women do not participate in community activities. Rural elderly engage in agricultural work which has no retirement age as such. In the west 'grey power' has become visible and viable. Older people go themselves organized to fight for their rights. They could achieve increased participation of women in labour force, policies of reservation for women in the political process and in decision making bodies. "Increased awareness regarding the demographic changes, improvements in the medical field that help control age related disabilities and more awareness on the part of the older people themselves could create a better society for older women of the next millennium".

H.S. Srivastava [2] analyzes the socio-economic effect of ageing along with health factors in his book, 'Managing Age'. There are three independent facts of age-physical age, mental age and moral age.

They have remote relationship. A carefree or care-shackled attitude of mind bears a direct relationship with ageing. Individual could be considered as old, when he is unable to perform his normal duties. Ageing is undoubtedly a normal biological process and there is no way of avoiding it, though there are many viable ways for slowing the process. Many changes that occur in old age are mainly due to disease and physical distress and the social and economic consequences of growing old. The loss of power and authority is a great disconcerting thing to happen and the individual suddenly finds himself at a loss to understand the phenomenon. The individuals in old age find it very hard to accept this situation when they are no more in power or authority. They feel as if adversity has caught them completely the characteristics which imbibe in young age tend to become more acute and compulsive in old age. A religious person can turn into a fanatic, a liar into a damn liar, a fastidious person into a cynic and so on. Life has become firefighting operation punctuated all the way by unanticipated emergencies. To the individual in old-age condition the long cherished values seem overturned. The things which old generations find as avoidable extravagance, the younger generations considered it as an unavoidable necessity.

In the book 'The ageing world' which is written by Anil Bagchi [3], the socio-economic status of elderly examined. According to the author, elderly become out of step with the economic environment and the changing technology. The old get cast off from the mainstream of life. Social interaction with younger people becomes infrequent. Thus society makes the person old. The conventional definition of old age definition is not realistic. It leads to excessive depressing forecasts. In this changing social circumstances, even centenarians, show mental acuity comparable to those who are decades younger. According to the author, mental senility is a creation of society. Thus ageing cannot be considered as a physiological process wholly. It has some social factors also. Some people live their old age excellently and to some purpose. Fast living people are likely to age faster and die earlier'. It is not a disease. It is the consequence of normal course of living. It is not the mischief of any foreign body. It is not due to any aberrant cell. The wealth difference existing between the nations is due to the difference in knowledge of sociology, science and technology. The increased wealth leads to the beginning of the formation of greater proportion of old age people—the greying of the developed countries. Thus there is a strong correlation between knowledge, wealth and greying. Wealth and culture among nations and communities are the important factors of grey dynamics. The less modern countries are now young. The traditional dependence of the elderly index is the number of the people above 65 divided by the number of people in the age group 18 to 64. Responsibility of elderly is considered as a national burden. In future, as the younger generation keeps growing wealthier than



their parents and grandparents, inheritance will have less than the all-important role that it plays today. This will have an effect on the inter-generational dependence. This leads to the independence of different generation. Some constraints associated with greying like political and security issues, ethical considerations are human creations and are therefore amenable to some extent. Within the boundary conditions we must look for solutions to the factors of our future. This book reveals the importance of sociological study in ageing.

Vijay Prakash Sharma [4], in his paper, 'Tribal Aging in Jharkhand Health Perspective' analyzed elderly in traditional region. The old have traditionally been honoured and respected. Those who neglected their old parents earned social disrespect and were ridiculed. Government of Jharkhand in its new health policy-2004 has announced that provisions for care of aged will be made. In 2002-03 Govt. of Jharkhand reported construction of two old age homes for elderly. This gave an idea about the involvement of State for the wellbeing of old.

In the paper, 'Status and Role of Elderly Persons in Tribal Communities of Chotanagpur (With Special Reference To Chik Baraik Of Jharkhand) by Karma Oraon and Pravin Kumar Jha [5] analyzed the social role performed by elderly. Changing pattern of family life brought repercussions on elderly folk. Elderly lead a happy life since time immemorial. One of the values of our society is the respect for elderly. They create a strong bond of union among the family members. Now the tribal family structure undergoes changes. This may be due to the impact of urbanization, industrialization, education, globalization and modernization. This paper gives the indication of factors which affect the elderly. According to the authors both generations have to make compromises and the failure to compromise leads to breakage of the family. Migration of children prompted older generation to migrate as well. But they don't get any engagements and are friendless. Thus they left for their village in despair and frustration. Their guardianship vanished. Educated younger generations are reluctant to respect them. Now a days, modernization leads to various attitudinal clashes. Elderly have to compromise to their fate. If this trend continues. India will lose her cultural glory.

However, an ongoing criticism of the social scientific study of ageing is that it lacks "theoretical rigor" and tend towards the descriptive. Thus research on ageing being primarily factor-driven rather than theory-driven. Kerala's elderly female folk are heterogeneous group. Factors of social exclusion of elderly women are different. We have to find out those factors which lead them to social exclusion.

METHODOLOGY

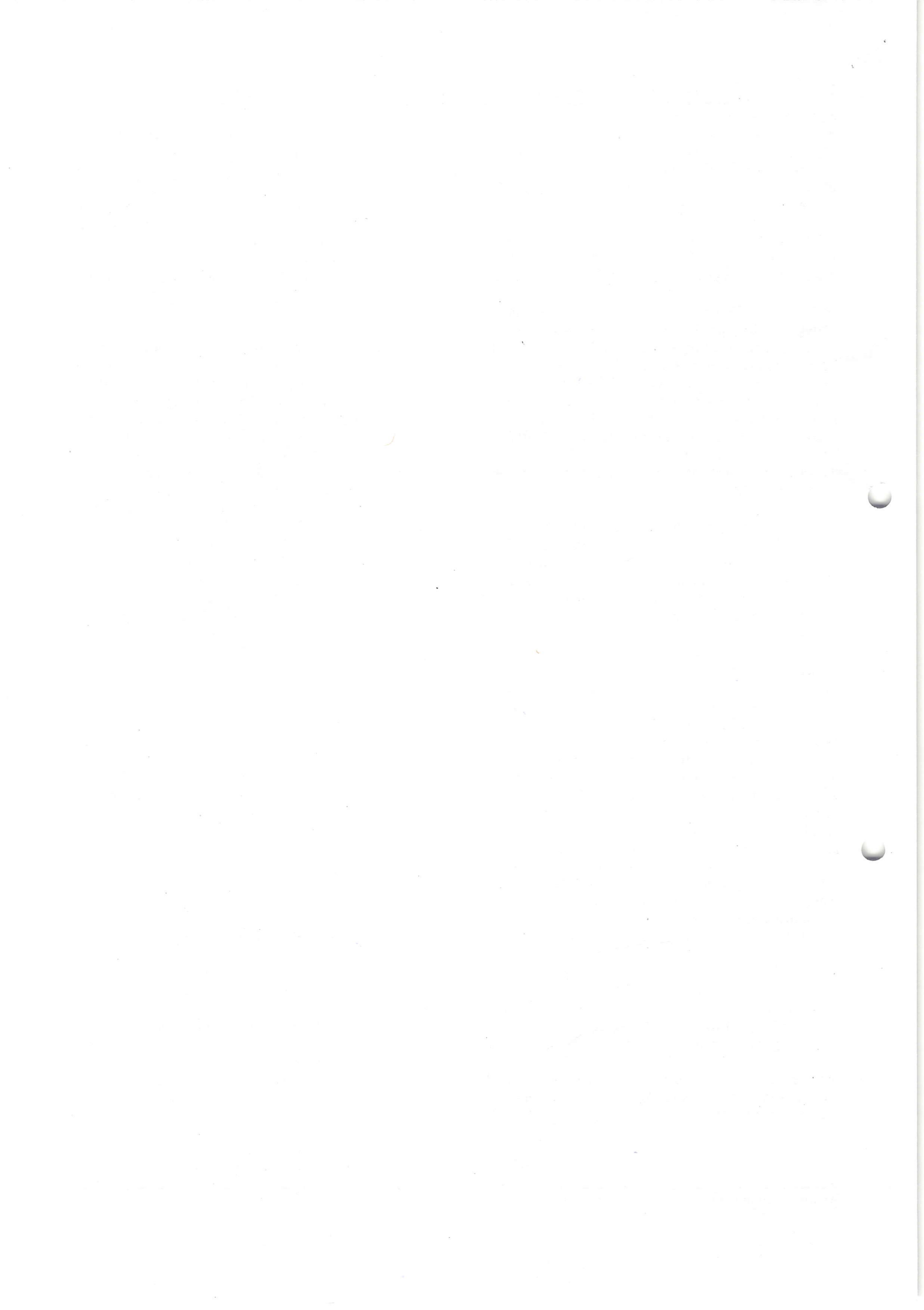
In Kerala as per 2011 census, the percentage of 60+ was 11.7 per cent and is projected to be 15.6 per cent in 2021. The elderly women represent the fastest growing age group in the population of Kerala. The threat of population ageing is more severe in Kerala than the rest of the country. Gender dimension of ageing is very significant in Kerala and female population predominates at all the stages of older ages. Population ageing could have profound implication for the economies as well as the societies. Thus the dependency ratio is greater.

A large number of elderly females are in the status of widowhood, illiterates, and non-working and belong to lower and or no income brackets. All these finding leads to the conclusion that the aged females are the vulnerable within vulnerable. Their miserable status makes them to appear more aged than actually what they are.' World Health Organisation Report 'states that the percentage of the aged women who are 60+is going to be doubled within two decades. But so far no specific study has been done to elevate their status. There will be lesser and lesser people taking care of the elderly as the decades roll by. Traditional life guards of family care are dwindling due to industrialization, our migration, dual career, female job participation and growing consumerism. All these make the well-being of the elderly, a growing challenge of the 21st century. A significant aspect of challenge comprises the depressed elderly along with society who are unwilling to accept them.

An overview of available studies revealed the fact that the majority of researches concentrated on the factors faced by the elderly women. A study based on the Social Exclusion Faced by Elderly Women has not been done. So the present study is undertaken with a view to explore information to fill the existing research gap. It is hoped that such a study would be helpful to the policy makers and society.

The scope of study is limited to the elderly women (60 years and above) residing in Thiruvananthapuram district, Kerala. The study on factors which lead them to social exclusion was being primarily problem-driven. Kerala elderly womankind is a heterogeneous group. They have to face a lot of factors of social exclusion during their existence. So this analysis is based on these factors. A single theory cannot explain all these factors. Various factors deeply intertwined to each of it. Descriptive research design has been adopted for this study. The purpose of this research design is to explore the factors which lead elderly women to social exclusion and elicit new information about the elderly women residing in old age homes in Kerala.

The objective of this study is to find out major factors lead elderly to social exclusion. The design uses



primary and secondary data. The primary data about the elderly for the study have been collected through structured interview schedule among elderly women in Thiruvananthapuram district. Two questionnaires are used for it. One is for members residing in home and the other is for members belonging in old age home. The secondary data are derived from books, journals, reports, newspapers and online media on the subject. 100 subjects from Thiruvananthapuram district is selected on simple random method. In the 100 elements, 50 residing in home and the remaining 50 from old age home. Data collected through structured interview schedule were analysed with SPSS.

OBJECTIVE

To explore the factors of social exclusion of elderly women.

DISCUSSIONS AND ANALYSIS

In this study 100 samples selected from Thiruvananthapuram district are considered as samples with the help of simple random sampling. Based on earlier studies the factors lead elderly to social exclusion are as: economic, familial, social, health, psychological and cultural. To identify the factors which lead them to social exclusion, researcher asked question in connection with it. According to their answer they are categorised. Based on the ranks given by the respondents to each factor a ranking analysis was carried out. Through this study researcher understood that the severity of the factors are different among elderly residing in home and old age home. Any one problem alone can acts as a leading factor for elderly to social exclusion. Several factors are together work hard to make an easy entrance to social exclusion.

Table-1: Rank Given by Elderly Women to the Factors of Social Exclusion

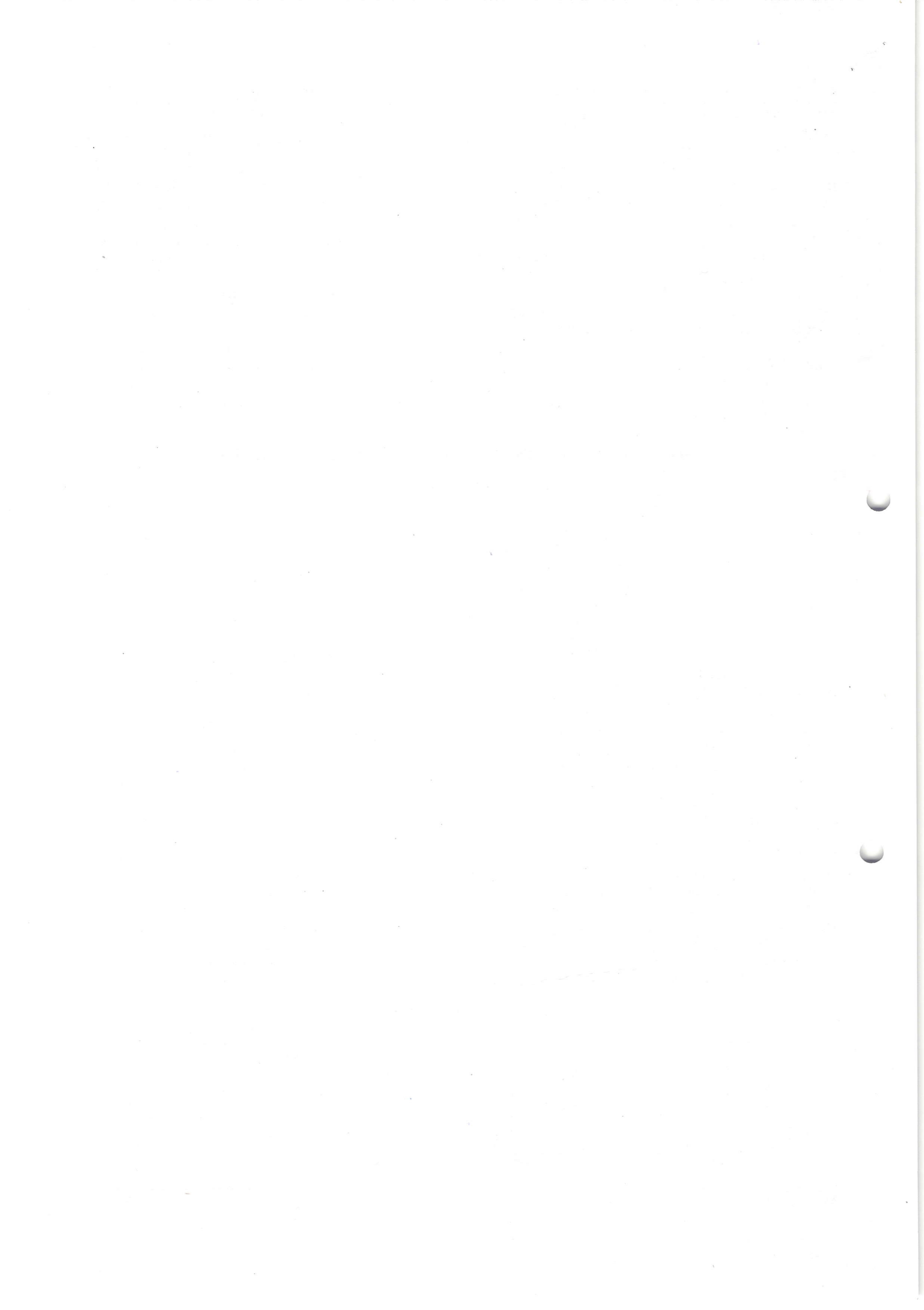
Major factors of elderly			
Rank	Home	Rank	Old Age Home
1	Health factors	1	Social factors
2	Economic factors	2	Economic factors
3	Family factors	3	Family factors
4	Social factors	4	Cultural factors
5	Psychological factors	5	Health factors
6	Cultural factors	6	Psychological factors

Old age is one of the stages in lifecycle. It is natural. In this stage they have to face life's most stressful experience [6]. In the above table (No.1) rank of the major factors of social exclusion of elderly residing in home and old age home are analysed. Major factors of social exclusion of elderly women are social, economic, familial, cultural, health and psychological. All factors are more severe in old age home. All these factors are faced by elderly residing in home, but not in a severe form. From this researcher found out that ranking of factors of elderly women residing in home and old age home are different. Elderly women residing in home give first rank to health factors while elderly residing in old age home give fifth rank to it. For elderly women residing in old age home, social factors are considered to occupy in the first rank. For both of them, economic factors have second rank and familial factors have third rank. Social factors have fourth place in ranking analysis for elderly in home. Psychological

factors have fifth rank and cultural factors have sixth rank for elderly residing in home. Cultural factors have fourth place in ranking analysis for elderly in old age home. Health factors have fifth rank and psychological factors have sixth rank for elderly residing in old age home. Elderly residing in old age home are in a deteriorated position due to the high intensity of factors like, economic, familial, social, health and psychological. From this researcher found out that elderly residing in old age home are in a deteriorated position due to the high intensity of factors like, economic, familial, social, health and psychological. They are vulnerable within the vulnerable. Elderly residing in home have factors but their percent is very minute and the order of intensity is different. Number of elderly in home have high level factors are very meagre. Then the social, economic and familial factors analysed separately based on the independent variable.

Table-2: Age and Social Factor

Age	Social Factor								Total
	Home				Old Age Home				
	Low	Medium	High	Total	Low	Medium	High	Total	
60-69	73 ²⁹ 85	50 ⁴ 12	50 ¹ 3	68 ³⁴ 100	---	---	39 ¹⁹ 100	38 ¹⁹ 100	53 ⁵³ 100
70-79	20 ⁸ 67	50 ⁴ 33	---	24 ¹² 100	---	---	45 ²² 100	44 ²² 100	34 ³⁴ 100
>80	7 ³ 75	---	50 ¹ 25	8 ⁴ 100	---	100 ¹ 11	16 ⁸ 89	18 ⁹ 100	13 ¹³ 100
Total	100 ⁴⁰ 80	100 ⁸ 16	100 ² 4	100 ⁵⁰ 100	---	100 ¹ 2	100 ⁴⁹ 98	100 ⁵⁰ 100	100 ¹⁰⁰ 100



The table no.2 analyses age with social factor. Out of 100 elderly 53 percent belong to young old, 34 percent to medium old and 13 percent to old old. Out of 50 elderly residing in home, 80 percent (40) have low social factor, 16 percent (8) medium factor and 4 percent (2) high factor. Out of 50 elderly residing in

old age home, 2 percent (1) have medium factor and 98 percent (49) high factor. Based on the above table (No.2) researcher found out that as age increases, the social exclusion also increases in home but in old age home as age increases, the significance of social factor in social exclusion decreases.

Table-3: Education and Social Factor

Education	Social Factor								Total
	Home				Old Age Home				
	Low	Medium	High	Total	Low	Medium	High	Total	
Illiterate	8 3 ¹⁰⁰	---	---	6 3 ¹⁰⁰	---	---	33 16 ¹⁰⁰	32 16 ¹⁰⁰	19 19 ¹⁰⁰
Primary	57 20 ⁷¹	74 8 ²⁷	100 2 ²	60 30 ¹⁰⁰	---	100 1 ¹	59 29 ⁹⁹	60 30 ¹⁰⁰	60 60 ¹⁰⁰
Secondary	29 13 ¹⁰⁰	---	---	26 13 ¹⁰⁰	---	---	6 3 ¹⁰⁰	6 3 ¹⁰⁰	16 16 ¹⁰⁰
Degree	4 3 ¹⁰⁰	---	---	6 3 ¹⁰⁰	---	---	2 1 ¹⁰⁰	2 1 ¹⁰⁰	4 4 ¹⁰⁰
>Degree	2 1 ¹⁰⁰	---	---	2 1 ¹⁰⁰	---	---	---	---	1 1 ¹⁰⁰
Total	100 40 ⁸⁰	100 8 ¹⁶	100 2 ⁴	100 50 ¹⁰⁰	---	100 1 ²	100 49 ⁹⁸	100 50 ¹⁰⁰	100 100 ¹⁰⁰

Table no.3 analyses education and social factor. Out of 50 elderly residing in home, 80 percent (40) belong to low factor category, 16 percent (8) to medium and 4 percent (2) to high. Out of 50 elderly residing in old age home, 2 percent (1) belong to medium and 98 percent (49) to high. From the above

table (No.3) researcher found out that major share of elderly residing in home have low level factors irrespective of their educational qualification. But the major share of elderly residing in old age home have high level social factors which lead to social exclusion irrespective of their educational qualification.

Table-4: Marital Status and Social Factor

Marital status	Social Factor								Total
	Home				Old Age Home				
	Low	Medium	High	Total	Low	Medium	High	Total	
Married	68 27 ⁹⁶	12 1 ⁴	---	56 28 ¹⁰⁰	---	---	2 1 ¹⁰⁰	2 1 ¹⁰⁰	29 29 ¹⁰⁰
Widow	30 12 ⁶⁰	88 7 ³⁵	50 1 ⁵	40 20 ¹⁰⁰	---	---	76 37 ¹⁰⁰	74 37 ¹⁰⁰	57 57 ¹⁰⁰
Separated	---	---	50 1 ¹⁰⁰	2 1 ¹⁰⁰	---	---	4 2 ¹⁰⁰	4 2 ¹⁰⁰	3 3 ¹⁰⁰
Unmarried	2 1 ³²	---	---	2 1 ¹⁰⁰	---	100 1 ⁵	18 9 ⁹⁵	20 10 ¹⁰⁰	11 11 ¹⁰⁰
Total	100 40 ⁸⁰	100 8 ¹⁶	100 2 ⁴	100 50 ¹⁰⁰	---	100 1 ²	100 49 ⁹⁸	100 50 ¹⁰⁰	100 100 ¹⁰⁰

Table no.4 analyses marital status with social factor. Out of 100 elderly 29 percent (29) belong to married, 57 percent (57) to widows, 3 percent (3) to separated and 11 percent (11) to unmarried. From this researcher found out that there is relationship existed between marital status and social factor. There is very meagre percent have high level social factor residing in

home. In the high level category widows and separated are included. This indicates the importance of marital status. In old age home the situation is different. Marital status has no significance in old age home. Majority of them belong to very high social factor. The atmosphere is horrible there.

Table-5: Region and Social Factor

Region	Social Factor								Total
	Home				Old Age Home				
	Low	Medium	High	Total	Low	Medium	High	Total	
Rural	88 35 ⁷⁶	75 6 ²²	100 2 ²	86 43 ¹⁰⁰	---	100 1 ¹	95 47 ⁹⁹	96 48 ¹⁰⁰	91 91 ¹⁰⁰
Urban	12 5 ⁷⁴	25 2 ²⁶	---	14 7 ¹⁰⁰	---	---	5 2 ¹⁰⁰	4 2 ¹⁰⁰	9 9 ¹⁰⁰
Total	100 40 ⁸⁰	100 8 ¹⁶	100 2 ⁴	100 50 ¹⁰⁰	---	100 1 ²	100 49 ⁹⁸	100 50 ¹⁰⁰	100 100 ¹⁰⁰

Table no.5 analyses region and social factor. Out of 43 rural elderly residing in home 76 percent (35) belong to low social factor, 22 percent (6) to medium and 2 percent (2) to high. Out of 48 rural elderly residing in old age home 1 percent (1) belong to medium and 99 percent (47) to high. Village is considered as the basic unit of social policy. The

inhabitants of the village had intimate social and economic relationship regulated by age old traditions and institutions [7]. From this researcher found out that there is more deteriorated position observed among rural elderly residing in home. But in old age home the urban elderly is more deteriorated.

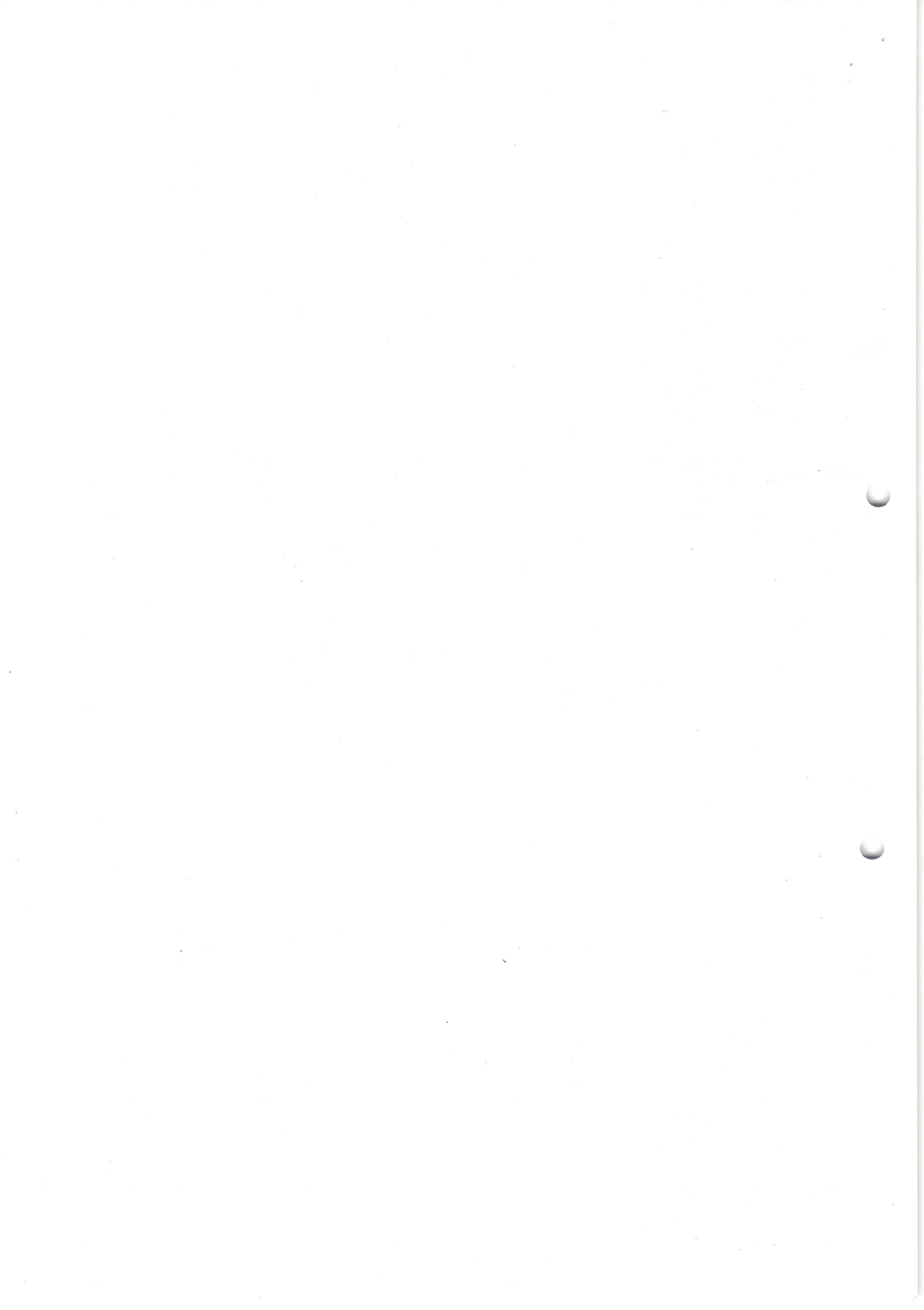


Table-6: Income and Social Factor

Income	Social Factor								Total
	Home				Old Age Home				
	Low	Medium	High	Total	Low	Medium	High	Total	
Nil	72 29 ⁹⁴	25 2 ⁶	---	62 31 ¹⁰⁰	---	---	97 46 ¹⁰⁰	92 46 ¹⁰⁰	77 77 ¹⁰⁰
<500	3 1 ⁵⁰	---	50 1 ⁵⁰	4 2 ¹⁰⁰	---	---	1 1 ¹⁰⁰	2 1 ¹⁰⁰	3 3 ¹⁰⁰
500-1000	5 2 ¹⁰⁰	---	---	4 2 ¹⁰⁰	---	---	1 1 ¹⁰⁰	2 1 ¹⁰⁰	3 3 ¹⁰⁰
1000-2000	---	---	---	---	---	---	---	---	---
>2000	20 8 ⁵³	75 6 ⁴⁰	50 1 ⁷	30 15 ¹⁰⁰	---	100 1 ⁵⁰	1 1 ⁵⁰	4 2 ¹⁰⁰	17 17 ¹⁰⁰
Total	100 40 ⁸⁰	100 8 ¹⁶	100 2 ⁴	100 50 ¹⁰⁰	---	100 1 ²	100 49 ⁹⁸	100 50 ¹⁰⁰	100 100 ¹⁰⁰

Out of 100 elderly, 77 percent (77) belong to non-income class, 3 percent (3) to less than 500 rupees category 3 percent (3) to 500-1000 rupees category and 17 percent (17) to above 2000 rupees category. From this researcher found out that income has not much influence in social factor. Among high level factor

holders equal number of elderly have less than 500 rupees category along with above 2000 rupees category. But the situation in old age home is entirely different. There major share has high level factors irrespective of their income. Their situation is very poor. They are vulnerable within the vulnerable.

Table-7: Age and Economic Factor

Age	Economic factor								Total
	Home				Old Age Home				
	Low	Medium	High	Total	Low	Medium	High	Total	
60-69	72 13 ³⁸	66 19 ⁵⁶	67 2 ⁶	68 34 ¹⁰⁰	---	---	40 19 ¹⁰⁰	38 19 ¹⁰⁰	53 53 ¹⁰⁰
70-79	22 4 ³⁴	24 7 ⁵⁸	33 1 ⁸	24 12 ¹⁰⁰	---	100 1 ⁵	44 21 ⁹⁵	44 22 ¹⁰⁰	34 34 ¹⁰⁰
>80	6 1 ²⁵	10 3 ⁷⁵	---	8 4 ¹⁰⁰	100 1 ¹¹	---	16 8 ⁸⁹	18 9 ¹⁰⁰	13 13 ¹⁰⁰
Total	100 18 ³⁶	100 29 ⁵⁸	100 3 ⁶	100 50 ¹⁰⁰	100 1 ²	100 1 ²	100 48 ⁹⁶	100 50 ¹⁰⁰	100 100 ¹⁰⁰

The table no.7 analyses age and economic factor of elderly. Out of 50 elderly residing in home 68 percent (34) belong to young old, 24 percent (12) to medium old and 8 percent (4) to old old. Out of 50 elderly residing in old age home 38 percent (19) belong to young old, 44 percent (22) to medium old and 18

percent (9) to old old. From this researcher found out that members residing in old age home have severe economic factor than the members in home. By analysing the above (Table No. 7) researcher found out that as age increases the severity of the factor decreases among members residing in home and old age home.

Table-8: Education and Economic factor

Education	Economic Factor								Total
	Home				Old Age Home				
	Low	Medium	High	Total	Low	Medium	High	Total	
Illiterate	---	---	100 3 ¹⁰⁰	6 3 ¹⁰⁰	---	---	33 16 ¹⁰⁰	32 16 ¹⁰⁰	19 19 ¹⁰⁰
Primary	30 6 ²⁰	83 24 ⁸⁰	---	60 30 ¹⁰⁰	---	100 1 ³	61 29 ⁹⁷	60 30 ¹⁰⁰	60 60 ¹⁰⁰
Secondary	50 8 ⁶²	17 5 ³⁸	---	26 13 ¹⁰⁰	---	---	6 3 ¹⁰⁰	6 3 ¹⁰⁰	16 16 ¹⁰⁰
Degree	15 3 ¹⁰⁰	---	---	6 3 ¹⁰⁰	100 1 ¹⁰⁰	---	---	2 1 ¹⁰⁰	4 4 ¹⁰⁰
>Degree	5 1 ¹⁰⁰	---	---	2 1 ¹⁰⁰	---	---	---	---	1 1 ¹⁰⁰
Total	100 18 ³⁶	100 29 ⁵⁸	100 3 ⁶	100 50 ¹⁰⁰	100 1 ²	100 1 ²	100 48 ⁹⁶	100 50 ¹⁰⁰	100 100 ¹⁰⁰

The table no.8 analyses education and economic factor of elderly. Out of 100 elderly 19 percent (19) belong to illiterate, 60 percent (60) to primary, 16 percent (16) to secondary, 4 percent (4) to degree and 1 percent (1) to above degree. From the above table (No.8) researcher found out that as education increases the severity of economic factor decreases in home, but this kind of relationship is absent in old age home. Among low factor holders residing in home, a gradual increase is observed as

education increases. This gives an indication about the importance of education in economic factor. Among elderly residing in old age home, majority of them have high economic factor without any exception of any educational levels. Knowledge explosion and industrialization made a gigantic change to society. This upset socio-economic set up of society. Transfer of economic authority from father to son made a social conflict.

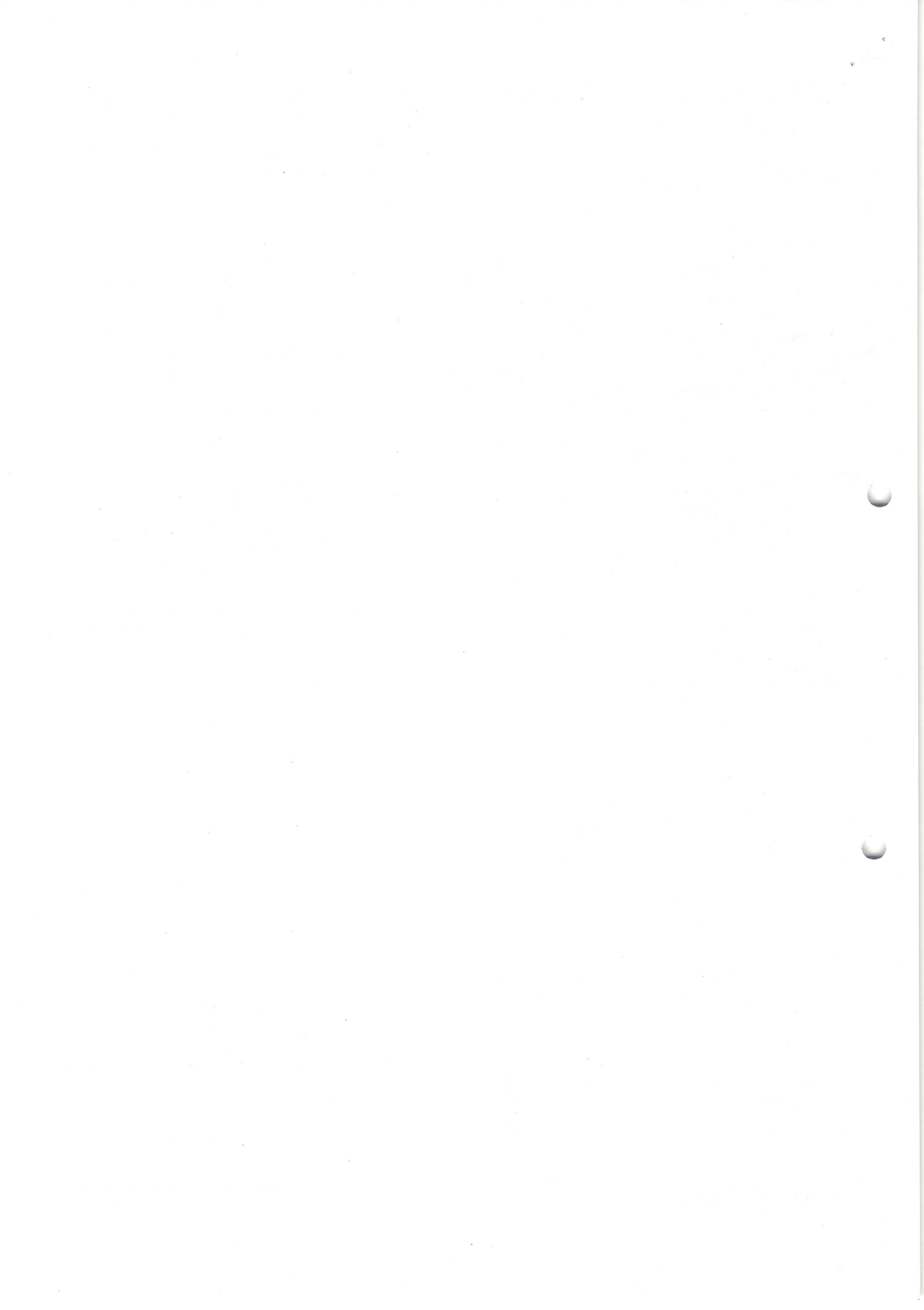


Table-9: Marital Status and Economic Factor

	Economic Factor								Total
	Home				Old Age Home				
Marital status	Low	Medium	High	Total	Low	Medium	High	Total	
Married	33 6 ²¹	76 22 ⁷⁹	---	56 28 ¹⁰⁰	---	---	2 1 ¹⁰⁰	2 1 ¹⁰⁰	29 29 ¹⁰⁰
Widow	61 11 ⁵⁵	24 7 ³⁵	67 2 ¹⁰	40 20 ¹⁰⁰	---	100 1 ³	75 36 ⁹⁷	74 37 ¹⁰⁰	57 57 ¹⁰⁰
Separated	6 1 ¹⁰⁰	---	---	2 1 ¹⁰⁰	---	---	4 2 ¹⁰⁰	4 2 ¹⁰⁰	3 3 ¹⁰⁰
Unmarried	---	---	33 1 ¹⁰⁰	2 1 ¹⁰⁰	100 1 ¹⁰	---	19 9 ⁹⁰	20 10 ¹⁰⁰	11 11 ¹⁰⁰
Total	100 18 ³⁶	100 29 ⁵⁸	100 3 ⁶	100 50 ¹⁰⁰	100 1 ²	100 1 ²	100 48 ⁹⁶	100 50 ¹⁰⁰	100 100 ¹⁰⁰

Table number 9 is analysed marital status with economic factor of elderly. Among high factor category, 67 percent (2) belong to widows and 33 percent (1) to unmarried. From the above table (No.9), researcher found out that marital status has significance in homely atmosphere and not in old age home.

Absence of married members residing in home in high factor category may be considered as the importance of marital status. The deteriorated position of elderly women residing in old age home is also confirmed through this table.

Table-10: Region and Economic Factor

	Economic Factor								Total
	Home				Old Age Home				
Region	Low	Medium	High	Total	Low	Medium	High	Total	
Rural	78 14 ³³	97 28 ⁶⁵	33 1 ²	86 43 ¹⁰⁰	100 1 ²	---	95 47 ⁹⁸	96 48 ¹⁰⁰	91 91 ¹⁰⁰
Urban	22 4 ⁵⁷	3 1 ¹⁴	67 2 ²⁹	14 7 ¹⁰⁰	---	100 1 ⁵⁰	5 1 ⁵⁰	4 2 ¹⁰⁰	9 9 ¹⁰⁰
Total	100 18 ³⁶	100 29 ⁵⁸	100 3 ⁶	100 50 ¹⁰⁰	100 1 ²	100 1 ²	100 48 ⁹⁶	100 50 ¹⁰⁰	100 100 ¹⁰⁰

Table no.10 analyses region and economic factor. Among high factor category, 33 percent (1) belong to rural and 67 percent (2) to urban. Among high factor category, 95 percent (47) belong to rural and 5 percent (1) to urban. From this researcher found out that

rural elderly residing in home have less complicated economic factors than urban elderly. But the situation is entirely reversed among elderly residing in old age home. There rural elderly have more complicated economic factor for their social exclusion.

Table-11: Income and Economic Factor

	Economic Factor								Total
	Home				Old Age Home				
Income	Low	Medium	High	Total	Low	Medium	High	Total	
Nil	6 1 ³	93 27 ⁸⁷	100 3 ¹⁰	62 31 ¹⁰⁰	---	---	98 46 ¹⁰⁰	92 46 ¹⁰⁰	77 77 ¹⁰⁰
<500	6 1 ⁵⁰	6 1 ⁵⁰	--	4 2 ¹⁰⁰	---	---	1.4 1 ¹⁰⁰	2 1 ¹⁰⁰	3 3 ¹⁰⁰
500-1000	6 1 ⁵⁰	3 1 ⁵⁰	--	4 2 ¹⁰⁰	---	---	0.6 1 ¹⁰⁰	2 1 ¹⁰⁰	3 3 ¹⁰⁰
1000-2000	---	---	--	--	---	---	--	---	---
>2000	82 15 ¹⁰⁰	--	--	30 15 ¹⁰⁰	100 1 ⁵⁰	100 1 ⁵⁰	--	4 2 ¹⁰⁰	17 17 ¹⁰⁰
Total	100 18 ³⁶	100 29 ⁵⁸	100 3 ⁶	100 50 ¹⁰⁰	100 1 ²	100 1 ²	100 48 ⁹⁶	100 50 ¹⁰⁰	100 100 ¹⁰⁰

The table no.11 analyses income and economic factor. Out of 100 elderly 77 percent (77) to non-income class, 3 percent (3) to less than 500 rupees category, 3 percent (3) 500-1000 rupees category and 17 percent (17) to above 2000 rupees category. From this researcher found out that economic factor highly influenced by income among elderly residing in old age home but the influence is very much limited among elderly residing in home. As income increases, the severity of factor decreases.

CONCLUSION

The dawn of twenty first century presents a new demographic structure to society. 'Ageing population' and 'Feminization among elderly' are the major ingredients of this presentation. More awareness about the negative consequences of these makes the

elderly female folk in utter confusion and misery which lead them to social exclusion. They struggle hard to acquire adequate spaces in society and majority of them fail to achieve. Objective of this study is major factors lead elderly to social exclusion. The design uses primary and secondary data. Primary data collected through structured interview schedule. Secondary data collected from books, journals, reports, newspapers and online media on the subject. Out of 100 samples from Thiruvananthapuram, 50 are from home and 50 from old age home. Collected data were analysed with SPSS.

Major findings of the present study are

- The rank order of factors of social exclusion of elderly women residing in home and old age home are different. Elderly women residing in home give first rank to health factor while elderly residing in



old age home give fifth rank to it. For elderly women residing in old age home, social factors are considered to occupy in the first rank.

- From this researcher found out that elderly residing in old age home are in a deteriorated position due to the high intensity of factors like, economic, familial, social, health and psychological.
- As age increases, the social exclusion also increases in home but in old age home as age increases, the significance of social factor in social exclusion decreases.
- Marital status has significance in social exclusion only for elderly residing in home but not in old age home.
- Researcher found out that there is more deteriorated position observed among rural elderly residing in home. But in old age home the urban elderly is more troubled.
- As age increases the severity of the economic factor in social exclusion decreases among members residing in home and old age home.
- As education increases the severity of economic factor decreases in home, but this kind of relationship is absent in old age home.
- When consider economic factor, researcher found out that marital status has significance in homely atmosphere and not in old age home.
- Rural elderly residing in home have less complicated economic factors than urban elderly.
- From this researcher found out that economic factor highly influenced by income among elderly residing in old age home but the influence is very much limited among elderly residing in home.

SUGGESTIONS

- Take necessary steps to increase awareness among elderly and society about their significant role have to play in old age.
- Make adequate action plans to increase their power and economic status.
- Steps should be taken to strengthen our familial and social bonds.
- Take necessary steps to increase the educational skills which help them an easy living in new advanced era and transferring this to increase income
- Help them to develop necessary precautions for managing their ageing process
- Should modify their communicative skills to prevent social exclusion
- Take necessary steps to increase their income.
- Make awareness among society members and elderly themselves about the importance of elderly.
- In this consumer world elderly must have contribute something to society.

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‘In-migration; aspirations and career enhancement of transgender Persons’

JISHA CHAKKUNNY M

*¹ Ph.D Research Scholar
Department of Sociology, Periyar
University, Salem-636011.*

&

Dr. SUNDARA RAJ T

*² Assistant Professor
Department of Sociology,
Periyar University, Salem-636011.*

ABSTRACT

Transgender people are the most oppressed and marginalized sections of India. Due to the hostile attitude of society, they are not able to succeed in life. But social change and development opportunities provide everyone with golden chances to show their individual skills. Transport facilities, push and pull factors leading to internal, national and international migrations. Each country provides individuals with opportunities to move to places where their abilities are recognized and freedom of action is ensured. A person's abilities, talents and skills greatly help one to excel in the profession. There are a lot of transgender people in India who have been very talented in their careers. In Kerala, several prominent transgender people have reached the top of their lives through systematic planning and ingenuity. This is a research paper on transgender who are in-migrants within the state of Kerala, who strive to excel in their careers by overcoming life's difficulties with great confidence.

Key words: ‘Migration, Ambition, Profession, Transgender.

INTRODUCTION

Migration is a global phenomenon. This can happen between countries, within and outside the country. People move to other places for various reasons. They do this to improve their lives. It is motivated by good jobs, economic profit and social acceptance. Transgender people are a neglected and outspoken minority in our society. Even though Kerala is culturally

high, transgender people are still unacceptable. Traditionalist thinking and antagonistic attitudes in the society are creating obstacles to their inclusion. Structural and social stigmas lead to many forms of discrimination. Transgender persons are totally unacceptable in the areas of education, employment and health care. Due to changes in the socio-cultural level and the progressive mindset, there are some differences in favor of transgender people.

They are quickly attracted to a place where they can work. They work there and live well. Thus transgender migrating to urban areas of Kerala and making their mark in the work place. In their own homes transgender are not recognized by their parents, siblings or other relatives. Even their friends keep them away from them because of their unusual behavior. They don't like places where people are just mocking and ignoring them. They move to a place where nobody cares about them and teases them. In addition, the good living conditions of urban areas attract transgender people.

A person's abilities, talents and skills greatly help one to excel in the profession. There are a lot of transgender people in India who have been very talented in their careers. In Kerala, several prominent transgender people have reached the top of their lives through systematic planning and ingenuity. They are able to work freely and earn money in their new place. Many studies show that the process of migration is a result of socio-cultural and economic factors. Women, men, children and people from different groups have different reasons for this. Just as there are many reasons to move from one location to another, there are certain factors that influence the choice of the right places. Transgender people tend to choose careers according to their tastes. They have good self-confidence and self-esteem. These people work hard to make the best of their jobs.

METHODOLOGY

The present study designed to find out the in-migration; aspirations and career enhancement of transgender persons. In this work researcher try to analyses the internal migration of transgender from rural to urban settings in Kerala, especially in Ernakulum district. Here transgender means that individuals who live with a different gender identity, gender expression and behavior pattern which is mismatched from their assigned sex at birth. Descriptive research design and snowball sampling method were used for the study. The tool of data collection was Interview schedule. The study was conducted among 50 transgender people who come to Ernakulum from different parts

of Kerala to find a job and now live here. Respondents belonged to the age group of 20 to 40 and were members of the 'Mudra' the CommunityBased Organization in Ernakulam.

RESULTS

This is a study of 50 transgender people who come from different parts of Kerala and live in Ernakulam city. It was conducted among 50 transgender people aged 20 to 40 years. From the total participants, 60% were Hindus, 10% were Christians, 26% were Muslims, and the remaining 4% were atheists. In terms of their living arrangements, 30% of the respondents live with their partners, 70% live with transgender friends. According to Stanislaus (1999) education leads to self reliance and involves self respect and self assurance which are helpful for the total upliftment of an individual. Among the total respondents 10% of them have only lower primary education 50% of them have upper primary education and 40% of them have high school and above. Transgender people are working and earning a good income. About 26% of transgender people have a monthly income of between 10000 to 15000. 44% of the transgender earning a monthly income is between 15000 to 20000. For 20% the monthly income is 20,000 to 25000. 10% of transgender people earn more than 25000 in a month. The following table outlines the major types of jobs that transgender people are engaged in their life.

Table1: Occupational status of the respondents

Occupation	Frequency	Percentage
Cochin metro workers	3	6%
Transgender shelter home employees	2	4%
Running beauty parlor	2	4%
Makeup artists	9	18%
Community Based Organization Staff	3	6%
Dance Teachers	7	14%
Shop Keepers	3	6%
Food Delivery Service	1	2%
Stitching and Tailoring Works	5	10%
Designers	4	8%
Modeling	3	6%

Stage programmers	5	10%
Jewelry makers	3	6%
Total	50	100%

DISCUSSION

James M Henslin (1997) states that the in-migrants always searching for a better life condition. Immigrants from rural areas to the city are liberated from many things. When they come here, they are completely freed from the family, religion, educational institutions and social institutions that are always trying to control their life and behavior. DehanjGhose and V N P Sinha (2005) argues all migrants from rural areas to urban areas are free from old traditional agencies. Internal displacement refers to the forced movement of the people within a country. Coffee Annan former UN Secretary General opined "internal displacement is the great tragedy of our time .The internally displaced people are among the most vulnerable of the human family."

The push and pull factors prompted transgender people who migrated to the region to find work and make a living. Push factors have mainly forced them to leave their places of birth. These include financial insecurity, unemployment, limited opportunities, intolerance, poverty, ridicule and lack of recognition. Security feeling, career choices, different Jobs, better employment opportunities, better wages, better living conditions, tolerance and individual freedom are some of the important pull factors that have attracted them to the city and helped them to live here.

All transgender people in this study live a good life with a variety of occupations. Unlike the traditional occupations of transgender people such as begging and prostitution, they are doing decent work. Getting higher education and good jobs is a natural desire of all human beings. But this is wrong for transgender people. The reason is that they are not getting the higher education, good job, or the opportunities they need. Here we see transgender people who work very well and earn income. Although they have experienced discrimination and violence in the workplace, they have adapted to the most conducive environment and are living well. It is with this in mind that they moved to the city, and the career chosen for them. These are all

positive changes. In this study, we can see that transgender people's vocation concerns and attitudes.

The research work shows 6% transgender are working in Cochin metro. 34% want to do their own business in the future. The biggest obstacle is the economic deficit. They strive to rise further in the profession and achieve many. 62% of them have utilized the benefits received from the Government of Kerala and the Social Welfare Department. 88% of respondents said they feel great satisfaction when they work and earn a good income. 24 percent said they use their income to support their families. They try to participate in the training and complete the courses to gain expertise in their areas of interest. They realize that all this has a profound effect on their career. Although many are not well-educated, they have found suitable employment and succeeded. 18% of them are makeup artists. They even work in the film industry. There are 6% of transgender people who work in a very flattering way in the modeling. In addition, they train and prepare for a variety of events, including school festivals, university-level competitions, and other stage events.

Mustafa Bilgehan Ozturk and Ahu Tatli (2016) says that transgender people face a lot of obstacles in their careers. Difficulties starting from the time of recruitment and selection persist throughout the careers of gender identity minorities and they have to endure much. 76% of respondents had a bitter experience with their work. 65% said they were proud and accepted by the community. 92% of respondents say they want to rise from their current social status. 96% of respondents said that they are constantly striving to reach their intended goal, regardless of any negative experiences. 76% have their own savings. 78% of respondents said that being able to work has eliminated the anxiety and uncertainty about life. They also shared that self-satisfaction gave them the sense that they were important people. 96% of respondents are confident that their transgender friends will always be there to assist in any of their needs. More than 90% of respondents feel that they need to be financially well off in order to have a good status in society. 70% of transgender people are capable of taking care of themselves. They are confident that they will be able to work and earn whatever they need. 88% of the respondents said that it is the society's duty to ensure that the fundamental rights guaranteed by the Constitution of India and the rights of justice, equality, liberty and equality as per Supreme Court judgments. 94% of

respondents said they needed good support from the community if they were to grow to the level they wanted.

CONCLUSION

Transgender people are one of the most neglected groups in Kerala. Nowadays transgender people have a habit of migrating to other parts of the country in search of jobs to secure their future. Their departure from Kerala to other states for looking a safer place has also decreased. Today, transgender people in urban areas of Kerala are getting decent and high-paying jobs. As a result of the new transgender policies of the Government of Kerala; they have seen some positive progress. They strive to make a decent living apart from the traditional forms of begging, sex work and dancing. They are striving to achieve self-sufficiency by participating in projects being implemented by the Social Welfare Department and Transgender Cell with the help of the Government of Kerala. They can live here only if we bring a radical change in the current way of our society. Transgender people need the support and encouragement of our Kerala community to find suitable employment, career advancement and socio-economic well being.

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PROBLEMS AND POSSIBILITIES OF TRANSGENDER ENTREPRENEURSHIP IN KERALA

Jisha Chakkunny M¹ & Dr. Sundara Raj T²

1. Ph.D. Research Scholar, Department of Sociology, Periyar University, Salem-636011, E-mail: jishachakkunny@gmail.com
2. Assistant Professor, Department of Sociology, Periyar University, Salem-636011, E-mail: drsrajsoc@gmail.com

ABSTRACT

Entrepreneurship was a male dominated phenomenon in the world. But in the modern era we are witnessing the gender equity between in all spheres of life. Today a transgender entrepreneur enjoys high status and positions in our society. But transgender entrepreneurs face multiple types of problems and challenges. It negatively affects their efficiency. The major objective of the study is to find out the major constraints confronted by the transgender entrepreneurs. Another aim is to provide the effective suggestions for the development of transgender entrepreneurship. In this study primary data collected through interview schedule and observation. Secondary data were collected from books, journals and internet. Samples are taken from the Thrissur district in Kerala. Snowball sampling method was used to collect the data. The study was concentrating 50 samples from the universe. The study shows both the internal and external factors affected the development of their entrepreneurship.

Keywords: Problems, Possibilities, Transgender, Entrepreneur and Entrepreneurship

*Corresponding author: drsrajsoc@gmail.com

Introduction

The emergence of the entrepreneurs in a society mainly depends upon the economic, social, cultural, religious and psychological factors. An entrepreneur is essentially a person who through his foresight and ability directs the application of human energy for organizing the enterprise. Entrepreneurship has been a male dominated phenomenon from the very early age, but time has changed the situation. The transgender also emerging as today's most memorable and inspirational entrepreneurs in the different parts of the world. Transgender entrepreneurship plays a vital role in creating jobs, innovation, growth as well as development in their life. It will help to enhancing the gender equality, empowerment and social inclusion of the transgender community.

In the words of Sharma "entrepreneurship demonstrates the inner quality, a creative and innovative response of the entrepreneur to changing environment." It is a perennial and perpetual process of development and reformation in every field of socio-economic endeavour. It connotes the philosophy of enterprise promotion, creation, proliferation, modernization and rehabilitation in the field of commerce, trade and industry. Actually small scale industrial units act as outlets for entrepreneurial talents and initiative. In the changed scenario awareness has motivated to transgender. Entrepreneurship opens up a new field for them and transgender can achieve their cherished profession which has independence and self support. Max Weber the classical sociologist says the spirit of entrepreneurship and its effectiveness is to a large degree affected by the prevailing climate of the region and culture. Culture through its values has a strong effect on entrepreneurial growth.

Today a transgender entrepreneur enjoys high status and positions in our society. But transgender entrepreneurs face multiple types of problems and challenges. It negatively affects their efficiency. The major objective of the study is to find out the major constraints confronted by the transgender entrepreneurs. Another aim is to provide the effective suggestions for the development of transgender entrepreneurship. In this study primary data collected through interview schedule and observation. Secondary data were collected from books, journals and internet. Samples are taken from the Thrissur district in Kerala. Snowball sampling method was used to collect the data. The study was concentrating 50 samples from

the universe. The study shows both the internal and external factors affected the development of transgender entrepreneurship.

Small Tempo of Transgender Entrepreneurship.

Transgender face different types of discriminations in all areas of life, especially in employment. The unstable careers and economic insufficiency is a major challenge for the transgender.

The socially constructed ideas are mainly unflavored for these people. Due to their gender identity and sexual nonconformity society considered them as a curse. The assigned gender role also creates a contradictory effect for their all initiatives. The cross gender characteristics and behavior pattern not accepted in the larger society. It is very difficult to come forward to the mainstream. They are struggling for a space in the community.

Discrimination, lack of social support, social stigma results the internal conflict and mental depression. The social hierarchy assigned to the transgender group is based on the nature of their professional engagement for their livelihood. In Kerala the people never give the mythical supernatural status to the transgender persons. They receive the supernatural status in other states of the country. They are considered as the sex workers and treated as the most vulnerable section of the society. The widespread nature of discrimination related with their gender expression also resulted they feel unsafe and ashamed in our social settings. The lower status of the minority group creating a separate category will lead to the stagnant lower position in the different spheres of life. In light of recent legislation the rise in successful legal action and a greater awareness of the rights of transsexual people in the workplace, it is clear that failure by employers and employees to eradicate such discrimination will have serious legal and economic implications. Transgender face several unique problems for their free movements in the highly gendered society. The unsupportive and rejection from family and society deletes their self confidence and self esteem, it is essential for a successful happy life. The talented transgender in different fields fear the discouraging societal attitude .They are unwilling to take the responsibility of the entrepreneurship.

Exclusion from the main stream of society

The existing patriarchal structure and social norms in our country have always suppressed the identity, dignity and even eligibility of those who belong to the 'transgender' category. They are the most marginalized and vulnerable communities with very pathetic and miserable living conditions and life situations. In Kerala context transgender subjugated to tortured and unvalued in the society. The inhuman treatment compelling them to migrate in other states of the India. The study reveals they are not significant persons in their family and fear of rejection from the society which caused their invisibility.

Transgender people who have always treated as inferiors in the mainstream .the unequal treatment and hesitation transgender forced to develop a unique life style. These differences are mainly in beliefs, habits, dress code, hair style, ornaments, cosmetics, food wear, entertainment, toilet practices, clapping and travelling nature. They confronted a series of issues from the public. The exclusion includes they cannot participate in social functions like engagement, marriage, housewarming, cultural and religious ceremonies. They are afraid the societies' unfavorable attitude, avoidance and humiliation. In some times they hide their transgender identity to their own protection. They are extremely excluded in the Kerala culture. It limits their freedom and living opportunities. They are highly invisible in the entire major domains of society. Not only discrimination but also exploitation in every parts of life is a serious problem. The society not accept and tolerant to this marginalized community. Harassment, abuses and reckons threaten their peaceful mind and normal life.

The social exclusion mainly reflected in all social institutions. The unfavorable attitude of staff and students caused the increasing dropouts among transgender people. It also limits their employment opportunities. It is a hurdle to get a better job. The enforced marriage and sexual exploitation is the major issues of the transgender. The lack of social integration leads to the increasing rate of suicide among transgender people in our state. The denial of basic necessities, rejection from the family and society are the important reasons for their suicide attempt. In Kerala has a lot of misconceptions related with gender identity. A radical change will happen through only with the powerful legislation. The transgender policy bill introduced by the Kerala government is a revolutionary step towards the upliftment of the transgender people in Kerala. The direct outcome of the policy bill is the better living condition and visibility of the transgender in our society. The transgender persons as the entrepreneurs are the remarkable achievement of the implementation of transgender

policy bill. The government provides more opportunities and financial help to this minority for new innovative strategies. The powerful legal support is very powerful and useful in the existing situation.

Factors Affecting Development of Transgender Entrepreneurship

Entrepreneurship is the outcome of certain traits which is found in the individuals that make them the successful entrepreneurs. The economic theory explains entrepreneurship emerges with the presence of certain economic conditions favorable to entrepreneurial activities. The socio-cultural theorists emphasize the entrepreneurship develop if a particular socio-cultural environment is Psychological theory proposes some psychological motives are responsible for the development entrepreneurship. Ironically the integrated theory proposes a set of factors responsible for generating entrepreneurship. On the basis of integrated approach several factors are responsible for the emergence of entrepreneurship. These are mainly internal and external factors. This different factors which affecting the development of transgender entrepreneurship are as following.

(A) Internal Factors

Internal factors arise or act from within or inside the transgender entrepreneurs. It is mainly the inner motives of the individual. The entrepreneurs here the transgender wish to work independently. This is the major reason for the development of entrepreneurship. The study shows 96% of the respondents are became the entrepreneurs, because of this reason. Transgender are the socially neglected category but they have the human desires and needs. Abraham Maslow's Hierarchy of Needs reveals the actual motivating factors of the entrepreneurship of the transgender. Here Maslow explains about the needs of self actualization and self realization through the fulfillment of the other needs. They are the human beings and they have their own person and social needs which motives them independently to achieve their needs.

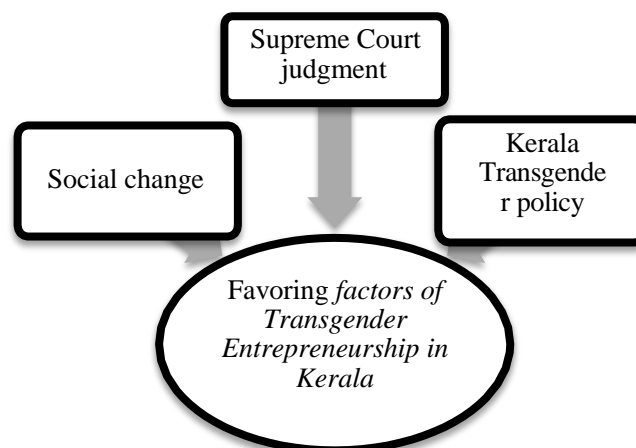
In the post modern era knowledge as well as money hold the power. It is essential for attaining the high social status and position in the society. The prestige issue is the real motivating factor behind their ambition to become the entrepreneur. 92% of the transgender agreed this reason. The situational reasons is a compelling or forcing reason for the entrepreneurship of the transgender. 90% of them opined this is the another factor for their entrepreneurship. They are pushed by their situation and the facilitating environment is the

supportive reason. Their work experience and self confidence which helps to start the new ventures. These internal factors or the personality traits of the individuals encourage them to select the entrepreneurship as their career. It is an opportunity and real challenge for these marginal people.

(B) External Factors

It is the opportunities and conditions which is favorable for entrepreneurship. The external environment has a vital role in the development of entrepreneurship. The major external factors are the financial factor. The availability of the financial assistance from banks and other financial institutions is an important external factor that promotes the entrepreneurship. The government and non government agencies supported the transgender entrepreneurs in their attempt to start a new attempt. The financial encouragement fostered the rate of transgender entrepreneurship. The training and guidance is available in the part of government and other concerned agencies, promoted their entrepreneurship. The post modern society is very open and meritocratic. It is the suitable condition for the transgender entrepreneurship. The members of the society are very generous in their outlook. Here ability and talents are valuable qualities. The open mind, positive attitude and mentality of the people also contributed the favorable condition. Beyond the traditional attitude on a day's society is more or less accepted the transgender as they are. These support systems and society are very external factor of entrepreneurship. The demand of the customer is the best scope for their entrepreneurship. The people are ready to accept the quality related goods and services. The availability of quality items and competitions also trained the transgender for better production and service. This increase their demand and necessity. The open market and free will also contributes the entrepreneurship in our society.

Figure: 1 Favoring Factors of Transgender Entrepreneurship in Kerala



Problems and Barriers of Transgender Entrepreneurs.

Transgender people in India face different types of problems. They are totally neglected community and excluded from effective involvement and denied the active participation of socio-cultural, economic and political participation. The study shows depth as well as intensity of the problems.

Lack of acceptance

Society is very doubtful about the abilities of the transgender. There is no history of successful transgender entrepreneurs in the country. Kerala people consider they are only sex workers. Nobody is willing to accept their abilities and talents.

Financial problems

Economically they are poor people. Their financial condition is very pathetic. The capital for the entrepreneurship is a difficult issue. Generally they have no any fixed income. So the transgender investment capacity is low. People are not ready to give any financial assistance to them.

Lack of technical knowledge

The higher education of the transgender is a difficult task. Only very limited persons attain high qualification. The technical knowledge is found at low level compared to others. They needed the technical education to become a successful entrepreneur.

Lack of decision making capacity

Their decision making capacity is very low. Transgender people never participate in any decision making process in their family. They do not have any courage to take risk in life. Entrepreneurship needs their greater involvement in entrepreneurial activities.

Lack of motivation

The aims and goals of the transgender people are very limited. Motivation .if we have a goal, we will boldly overcome any crisis..Lack of purpose is a major drawback of the transgender entrepreneurship

Lack of awareness

Nowadays government and other private lenders are willing to finance them. But they are not aware of it. Moreover, transgender people are not aware of training programs and awareness classes that are held for entrepreneurs.

Different types of discriminations.

Transgender entrepreneurs experience social, cultural, religious political and gender discriminations. How well they perform, no one accepts or encourages them. That undermines their self confidence. This adversely affects their performance.

Gender bias

Gender bias affects them very much. Society not valued their existence and presence. It is also an issue of society's attitude. Others in the society regard transgender as inefficient and useless. This prevents the entrepreneurs doing well.

Accommodation problem

This is one of the biggest problems. They are always viewed with the eye of a doubt. Transgender do not always have the necessary facilities to do their work. Because of this, many of their ventures have to quit. All these problems always hinder their activities.

Entrepreneurship demand high level of sociability and mingling capacity. Lack of self acceptance negatively affects the relationship. It reflects in all activities. A transgender entrepreneur has various obstacles in their life. It is so large that we cannot be numbered. The main barriers illustrated in the following table.

Table: 1 Barrier of Transgender Entrepreneurs.

Barriers	Number of respondents		Total
	Yes	No	
Avoidances	44(88%)	6(12%)	50(100%)
Conservative outlook of the people	36(72 %)	14(28%)	50(100%)
Denial of access to public accommodations	42(84%)	8(16%)	50(100%)
Economic constraints	44(88%)	6(12%)	50(100%)
Exploitation	40(80%)	10(20%)	50(100%)
Fear of taking risk	38(76 %)	12(24%)	50(100%)
Feeling of depression	32(64%)	18(36%)	50(100%)
Gender discrimination	48(96 %)	2(4%)	50(100%)
Gender dysphoria	42(84%)	8(16%)	50(100%)
Inadequate managerial skills	26(52%)	24(48 %)	50(100%)
Lack of education	30(60 %)	20(40%)	50(100%)
Lack of encouragement	40(80 %)	10(20 %)	50(100%)
Lack of family support	36(72%)	14(28%)	50(100%)
Lack of self confidence	26(52 %)	24(48%)	50(100%)
Lack of self esteem	38(76%)	12(24 %)	50(100%)
Maltreatment	38(76%)	12(24 %)	50(100%)
Rejection and prejudices	44(88 %)	6(12%)	50(100%)
Social exclusion	44(88 %)	6(12 %)	50(100%)
Social stigma	46(92 %)	4(8 %)	50(100%)
Tough competition	30(60%)	20(40 %)	50(100%)
Unfavorable attitude of society	46(92%)	4(8%)	50(100%)
Violence at workplace	32(64 %)	18(36 %)	50(100%)

Supportive Measures and Strategies for Transgender Entrepreneurship

In the male dominated world all the weaker sections of the society struggling to establish their identity in the social system. It is essential to take right actions for the development of transgender entrepreneurship. They need special attention and support, trainings and meritorial awards etc. Vocational training is essential for the transgender entrepreneurs. The supportive measures include the different types of financial assistance, accommodation facilities,

Transgender friendly policies will encourage them to participate effectively in the development process.

For the greater participation in the entrepreneurial activities need the grossness to introduce certain strategies for the effective development of transgender entrepreneurs. Firstly we must consider they are a special target group. Provide the better educational facilities and ensure their utility of the opportunity. Conduct the training programs to improve their managerial skills. Give support their imitativeness. Organize vocational and soft skill training programs. Help to enhance their professional competence and leadership qualities. Adequate training and continuous monitoring system discarded one. Start counseling facilities for the needy persons. Take actions for bestowing more capital assistance by the government and other finance corporations. The table gives a clear idea about the strategies.

Figure: 2 Strategies for Transgender Entrepreneurship



Suggestions

Ensure equality: According to the Indian constitution, all citizens are equal. Article 15 guarantees the fundamental right to equality. This equality must also be ensured in the comprehensive areas of life. As a citizen of India, transgender people need to ensure this equality. They should have the opportunity to engage in any kind of decent work they like.

Protection from violence and exploitation: Violence and exploitation should be eliminated, which is the critical problems of transgender entrepreneurs. We need to protect them from all kinds of exploitation. It is the duty of each of us.

Schemes and Programs for empowerment: Transgender people are deprived of even the basic amenities in life. We have to give them all the help they need to increase their knowledge and work skill. This will help their financial well being. Then only transgender make a profit by engaging in new jobs with confidence. The government has to come up with many schemes that provide financial assistance to the transgender entrepreneurs.

Empowerment through Education: We can raise the social position of the transgender people only by giving them a good education. They also need special learning facilities. They should be able to talk and share their problems. Their status can only be enhanced by providing good education. That way we can lift them up.

Accept the society: Any change begins with the acceptance of society. For the transgender people to have a good place in our society, we must embrace them with our minds. All the necessary programs have to be organized at the government level and all humanitarian considerations have to be given to them by civil rights.

Soft skill and Vocational training: We should be able to enable them to earn enough for their livelihood. Soft skills training and other vocational training are ways to help them become self sufficient. They must work, earn their own income and live well. This is empowerment. The way to do this is entrepreneurship.

Confidence building workshops: It is very essential to give the confidence building training to the transgender entrepreneurs. A person can use his skills properly only when he has confidence. Those who face ridicule and neglect from society will never have self esteem. Everyone can do well if they have faith in their own abilities. Therefore, we should organize workshops for transgender people to build self confidence.

Technology based knowledge classes: Technology based knowledge classes can be a great help to entrepreneurs if they get before starting a business.

Thus more and potential transgender candidates should be motivated to join entrepreneurial activities. Today government and voluntary organization had taken different developmental programs for the upliftment of transgender.

Hope the Colorful Future

The recognition of transgender is one of the most important events of the modern age and our society is ready to accept them. Despite its limitations, transgender people have a place in our society. One of the main reasons is the change in attitude of the people. The society is ready to accept their limitations. Society values these people and tries to give them equality in everything. Transgender people are being accepted everywhere in all walks of life. Those who were once deemed despicable are now being given a place of honors in society. The recognition of the people makes it clear that they have a place in the general mind. This is a very positive thing. It is very important to take the oppressed and neglected into the main stream. This shows the infinite possibilities for development ahead of them.

In the past the condition of transgender is worse in Kerala than any other states. This is related with our traditional viewpoint of gender binaries. It is very sad for transgender people to be excluded from social relationships. That limits the development possibilities of their lives. They do not come into the mainstream in Kerala society. The government of Kerala has made many changes in order to reverse the situation and improve their condition. Kerala government enacted legislative measures for the transgender. To protect constitutional rights and privileges, the government of Kerala has implemented a transgender policy in the state after Supreme Court Judgment. This gave them the right to legal protection to exercise their rights. Transgender people have a situation where they can live just as any other citizen. The state gives them the opportunity to engage in work suited with their talents. This demonstrates the great potential they have in their careers. They can perform tasks based on abilities. Yes, the horizon opens up a huge scope for transgender to work according to their skills. As an entrepreneur, there is a situation in Kerala today where transgender are allowed to work. The existing condition is that enables them to work on their feet freely and happily. A bright future awaits the transgender community.

Conclusion

Entrepreneurship was a male dominated phenomenon in the world. But in the modern era we are witnessing the gender equity between in all spheres of life. Today a transgender entrepreneur enjoys high status and positions in our society. But transgender entrepreneurs face a various types of problems and challenges. This study has assessed the problems and

possibilities of transgender entrepreneurship. The income generating business activities is a feasible solution for the better status and empowerment of transgender in our society. Their own income will help them stay on their feet. Financial self-reliance is something that boosts our confidence. So it is the best time we can focus our genuine actions for the upliftment of the transgender people by increasing their work participation and entrepreneurship.

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Transgender: A Marginalized and Alienated Community

Jisha Chakkunny M

*Department of Sociology, Periyar University, Salem-636011,
E-mail: drsrajsoc@gmail.com, jishachakkunny@gmail.com*

&

Dr. Sundara Raj T

*Department of Sociology, Carmel College, Mala, Thrissur-680732,
E-mail: jishachakkunny@gmail.com*

Introduction

Gender is a multifaceted, construct, a complex phenomenon viewed differently in different societies. The most important impact that gender created in the society is the assigning or segregating the work load among the two dominant group the male and female. The relatively smaller group in population, the transgender is facing inequality and condemnation by this patriarchal society. Living as a transgender someone who identifies with a gender different than one assigned at birth is an experience filled with stress, strain and tensions. Transgender persons who are largely marginalized from the mainstream society because of the social stigma related to the gender identity. It negatively affects their mental wellbeing. The social exclusion results the different types of discriminations towards this minority group.

The God's own country, Kerala is the first state to introduce a transgender policy in 2015. The State has passed the Transgender Bill in an attempt to bring them to the mainstream of social life. However, discrimination, exclusion, suppression and oppression against transgender persons still continue from all walks of life. Transgender suffer from the lack of continuity in their identity, lack of self esteem, over emphasized and unwanted distinctiveness and injustice at every turn. This study intended to expose sufferings, discrimination and marginalization of transgender and try to explain every day issues of transgender through the sociology of third gender.

Gender equality refers to people receiving equal opportunities to realize their full human potential according to their wish, irrespective of gender. This includes equality in opportunities to take part in social, economic, cultural and political developments and benefiting equally from the results. It can also refer to the equality in protection of human rights. People are not aware about the gender issues especially transgender problems in the present society. Our constitution is guaranteeing fundamental rights for all human beings. But we are creating variety of boundaries for the transgender.

Methodology

The objective of the study is to identify the major problems confronted by the transgender. Research design of the study is descriptive in nature. Transgender people who are living in Kerala formed the Universe of the study. Fifty Samples are taken from the Thrissur district in Kerala. Snowball sampling method was used to collect the data. For this study, both primary and secondary sources of data are used. Primary data collected through interview schedule. Secondary data were collected from books, journals and internet.

Discussion and Results

In the modern complex society transgender confronted a lot of problems. Discrimination, disrespect, inequality, rejection, unwanted attention are the major difficulties of their life. They have restricted access to education, health services, and public spaces. They are denied from the political, religious and recreational involvements with the public. The Constitution provides for the fundamental right to equality, and not allowed any discrimination on the grounds of sex, caste, creed or religion. The Constitution also guarantees political rights and other benefits to every citizen. But the third community continues to be oppressed. The analysis reveals the present conditions of the transgender in our society.

The study shows that 94% of the respondents are not satisfied with their present condition. Transgender faces avoidance in all spheres of life. People living together in a community make up a society, and anything connected to that group can be described as societal. Societal pressures are expectations that influence the entire community, especially the existing social stigmas effect negatively to the transgender. So they are not gratifying by the present condition. The analysis indicates nobody is happy with the attitude of society towards them. All of them are opined that the societal attitude is not favorable to them. It means society is not giving any consideration to the transgender. The study shows in Kerala people are more conservative in nature. Society have very negative attitude to these persons. It creates the adjustment problems in the life of transgender The study clearly reveals that a great majority of the respondents openly said that people are more conservative and they have a negative attitude towards them. This situation creates discrimination and a lot of adjustment problems in the everyday life of Transgender.

In Kerala the transgender faces extreme type of avoidance from their fellow beings. This is mainly due to the conventional culture of gender binaries. A well proportion (90%) of the

respondents in this study feel that the society is not considering them and always avoiding them.. This avoidance and negligence always pull them back from public spaces. Actually transgender are very talkative, enthusiastic and friendly in nature. But the people are not ready to communicate with them. The exclusion from the social interactions leads transgender people into several distresses, tribulation, deprivation which further limits their opportunities. It also denies their visibility in all major domains of society.

The study reveals that a little more than half (54%) of the respondents often face negative experiences from the society. The society considered the transgender as a social deviant who have certain psychological problems. There no acceptance from the family and their community. At present our society is not successful in providing the facilities for the transgender to get their livelihood requirements. Not only providing the opportunities but also blaming for their mistakes.

Equality is a fundamental human right. It guarantees in our constitution. The right of equality before law and equal protection of law is guaranteed under Article 14 and 21 of the Constitution. The right to chose one's gender identity is an essential part to lead a life with dignity which again falls under the ambit of Article 21. The Court has given the people of India the right to gender identity. Further, they cannot be discriminated against on the ground of gender as it is violation of Articles 14, 15, 16 and 21. But transgender people are discriminated in our society in all walks of life. In public places like bus stands, railway stations, theatres, temples, educational institutions, offices, malls, beaches, playgrounds, even within the public toilets they are offended and insulted. The society considers transgender are not normal as the other members of the society. One of the largest reasons that transgender face inequality and feel inferior is due to the lack of public understanding of transgender people. This cause low self respect, self esteem self confidence and self acceptance within them.

Table-1: Feelings of Respondents

Feelings of respondents	Number of respondents		Total
	Yes	No	
Self respect	12(24%)	38(76%)	50(100%)
Self esteem	10(20%)	40(80%)	50(100%)
Self confidence	18(36%)	32(64%)	50(100%)
Self acceptance	13(26%)	37(74 %)	50(100%)

On respondents feelings about themselves shows that only one fourth (24%) have self respect, while about three fourths do not have any self respect. About one fifth only have self esteem, while a great majority does not have any self esteem. A little more than one third feels self confidence. While others (64%) do not have self confidence. A little more than one fifth only accepted themselves. Self respect helps to fulfill our potential, develop healthy relationships. If we truly respect ourselves, then we can accept ourselves as well as others. The present study shows they have low level of self respect, self confidence and self esteem. Healthy self esteem originates in the environment found in the family, school, peer group, work place, and community. For healthy self esteem individuals need to receive nurturing from the people in their environment. Self control is the ability to regulate one's emotions, thoughts, and behavior. The ability to control ourselves helps to boost our feeling of self esteem. Here the transgender persons are very poor in the self respect, self esteem, self confidence, self acceptance, and self control. Our society has a vital role in these personality traits. They feels the society is under valuating and under estimated them. This attitude of transgender itself acts as a barrier to uplift their life.

Table-2: Types of Difficulties

Types of difficulties	Number of respondents		Total
	Yes	No	
Economic difficulties	46(92%)	4(8%)	50 (100%)
Lack of family support	39(78%)	11(22%)	50 (100%)
Difficulty with identity	38(76%)	12(24%)	50 (100%)
Avoidance based on transgender	45(90%)	5(10 %)	50 (100%)
Difficulties in social participation	48(96%)	2(4%)	50 (100%)
Difficulties in political participation	49(98%)	1(2%)	50 (100%)
Difficulties in religious functions	46(92%)	4(8%)	50 (100%)
Difficulties while using public facilities	48(96%)	2(4%)	50 (100%)
Difficulties in Education	47(94%)	3(6%)	50 (100%)

The table 2 on distribution of Respondents by their difficulties in various life situations shows that Except a few almost all suffer from various difficulties such as economic difficulties (92%), participation in social activities (96%), political participation (98%), religious participation

(92%) and feel avoidance (90%). A more than three fourths (78%) are not getting any support from family and feel homelessness. Another three fourths (76%) feel identity crisis

We have to experience all kinds of difficulties throughout our lives. Everyone has problems in life. For the most part, we are able to quickly solve them without much trouble. Problems become more difficult it is impossible to lead a happy life. Here the table shows different types of difficulties faced by the transgender. The major difficulties faced by the transgender are the economic problems, absence of family support, identity crisis, different types of avoidance, and difficulties in social, political and religious participation. The mentality of the society is not strong enough to support the transgender as to accept them in the mainstream of the society.

Transgender experience discrimination in their everyday life. The major one is they have very limited employment opportunities. This study shows that 96 % respondents are say that government is not giving opportunities to them.4 percentage of the minority respondents are says that the government giving opportunities to them. In real life situations in any of the areas government is not taking any actions to support them. But The Transgender Persons (Protection of Rights) Bill 2016 was introduced in Lok Sabha on August 2, 2016 highlights a transgender person must obtain a certificate of identity as proof of recognition of identity as a transgender person and to invoke rights under the bill. The bill prohibits discrimination against a transgender person in areas such as education, employment, and healthcare. It directs the central and state governments to provide welfare schemes in these areas.

The study shows that 92% of respondents are believe that the new generation accepts the third identity. Teens are more broadminded persons and they accepting all changes in the society. They oppose the entire conservative and traditional outlook and believe. The study also reveals the other problems that are being faced by the transgender community are unemployment, lack of educational facilities, homelessness, and lack of medical facilities, depression, social exclusion and problems related to marriage.

The rule of law is supreme and everyone is equal in the eyes of law in India. Yet, the transgender community is in a constant battle as they have to fight oppression, abuse and discrimination from every part of the society, whether it's their own family and friends or society at large. The life of transgender people is a daily battle as there is no acceptance anywhere and they are ostracized from the society and also ridiculed.

Implications of the study

Transgender are constantly targeted for abuse. They suffer cruel, inhuman and degrading treatment, including a constant threat of violence that amounts to torture, forced disappearances and sexual violence. The International Protection for the Human Rights of Transgender guarantees all people are entitled to enjoy the protection afforded by international human rights law. Transgender are no exception. The non-discrimination principle, recognized in the UN Charter, the Universal Declaration of Human Rights, and other basic human rights treaties, including the International Covenant on Civil and Political Rights, mandates that the rights recognized in these treaties are ensured to all individuals, without any distinctions based on race, color, sex, national origin, religion or political opinion or other status. The “other status” clause invites the recognition of new grounds upon which discrimination is prohibited, such as sexual orientation and gender identity. It is now well-recognized that discrimination based on sexual orientation and gender identity violates the non-discrimination principle. The obligation to “respect” the right to equality prohibits any discrimination to “ensure” that right requires states parties to protect individuals from discrimination. This study recognized, affecting basic aspects of ordinary life such as work or housing, individuals are to be protected from discrimination within the article of right to equality. The right to personal security also obliges States parties to take appropriate measures in response to death threats against persons in the public sphere, and more generally to protect individuals from foreseeable threats to life. Unfortunately, Kerala has failed in this obligation. The high number of murders and other violent attacks against transgender individuals is stark evidence of the very hostile and violent environment for the transgender population that persists in Kerala. By failing to take adequate measures to protect transgender individuals from such attacks, Kerala is violating its positive obligations with respect to the rights to life and personal security under different Articles.

Conclusion

In Kerala Transgender face discrimination within their own family units and schools, in employment and housing, within government settings, and under the justice and legal systems. The main problem in the society is that there is no proper awareness and understanding of the transgender community and many of them are not accepting even they are human beings. Support from family and society is very essential for their upliftment. The transgender are averse against the society when the basic respect is refused by the society and when they receive ill-treatment

from the society they expose their arrogant activities to safeguard themselves. Marginalization deprives the transgender from their maximum potential for prosperity and denies even in gender related opportunities. It is wrong to judge and discriminate the persons who are different from the stereotype, which is created by human beings. A radical change in the life of transgender people is possible only through powerful legislation. The transgender policy bill introduced by Kerala government shows light on transgender issues and further steps for the upliftment of transgender people. The urgency of the era is the inclusion strategies for overcoming discrimination, inequality and stigmatization.

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WOMEN EMPOWERMENT THROUGH SELF HELP GROUPS (SPECIAL REFERENCE TO MALAGAMA PANCHAYATH)

JISHA CHAKKUNNY M

Assistant Professor

Department of Sociology, Carmel College Mala Thrissur, Kerala.

ABSTRACT

All over the world there is a realization that the best way to tackle poverty and enable the community to improve its quality of life is through social mobilization of poor, especially women into Self Help Groups. The Indian government adopted the approach of SHGs to uplift the rural poor women within the Ninth five year plan. The Self Help Groups, launched and implemented by the government of India for the empowerment of Women and poverty alleviation, play important role in the holistic development of various sectors in the rural areas. It has also enabled Women to make progress in the socio-economic spheres. According to the result of the study, Women through SHGs have been able to greatly participate in income generated activities and increase their savings, thereby achieving financial security and working for the common good of the community by social involvement.

Keywords: Women, Decision making, Empowerment, Self Help Groups, Participation, Leadership.

INTRODUCTION

Empowerment is the process by which the disempowered or powerless people can change their circumstances and begin to have control over their lives. Empowerment results in a change in the relationships; perhaps the most important effect of empowerment is that is the person says

'now I never feel fear'. Women empowerment means women are able to have control over their resources, and they can take decisions about their life, their children and family and also contribute to the community decisions.

Women have through the centuries, remained cloistered confined within the four walls of the home and dismissed as the second sex, in the society. But today their statuses are drastically changed in their position. Now a day's government and voluntary organizations had taken many developmental programmes for the upliftment of women. Self help groups is a small economically homogeneous and affinity group of a rural poor which is a voluntary ready to a common fund to be lent to its members as per groups decision which works for groups solidarity.

OBJECTIVES

The objectives of the study Includes (a) To examine the socio-economic condition of the respondents after joining in Self Help Groups. (b) To analyze the empowerment of women through SHGs.

METHODOLOGY

UNIVERSE AND SAMPLE

Universe of the study is women who have membership in self help groups. Samples are taken from the Self Help Groups in Mala Gama Panchayath. Simple random sample method was

used to collect the data. The study was concentrating 50 samples from the universe.

TOOLS AND METHODS OF DATA COLLECTION

Primary data collected through interview schedule. Secondary data were collected from books, journals and internet.

RESEARCH DESIGN

The nature of the design referred in this study is descriptive.

VARIABLES

In this study Age and Education is considered as independent variables. Leadership quality, Monthly savings, Participation etc are the dependent variables.

ANALYSIS

SHGs a mini voluntary agency for self help at the micro level has been a focus on the weaker sections particularly women for their social defense. SHGs has got great potential in creating awareness on day today affairs, promoting in savings habits, developing self and community assets, increasing the income level, increasing the social power etc. It generates confidence self-scrutiny and self-reliance. The analysis reveals the changing status of rural women through SHGs.

TABLE 1 : DISTRIBUTION OF RESPONDENTS BASED ON AGE

Age	Number of respondents	Percentage
20-30	9	18%
30-40	23	46%
40-50	11	22%
Above 50	7	14%
Total	50	100%

The majority of the respondents were below 40 years of age group. Only 14% were above 50 years.

TABLE2: EDUCATIONAL LEVEL OF THE RESPONDENTS

Education	Frequency	Percentage
Lower primary and below	16	32%
Upper primary	25	50%
High school and above	9	18%
Total	50	100

The table shows that among the respondents only 32% of them have lower primary education. 50% of them have upper primary education and 18% of them have high school and above.

The main expectations of the respondents from SHGs were economic betterment, capacity building and status improvement. All the respondents were of the opinion that not only Government but Non Governmental bodies were also given full support to them. Voluntary organizations were acting as the promoters, trainers and executors to facilitate group activities. Both Government but Non Governmental bodies gave help for their improvement. Whole respondents were opined that SHG s is fruitful one. Almost all they were benefited from it.

In rural India lower level of economic status of women underline the need to accelerate their earning power by providing the income generating assets. Provisions of employment opportunities and income to rural women are one way to improve their nutrition, health, education and social status.

TABLE3: INCOME GENERATED ACTIVITIES UNDERTAKEN BY THE SELF HELP GROUP MEMBERS

Income Generated Activity	Number of respondents	Percentage
Textile	7	16.27%
Cottage industries	3	6.9%
Animal husbandry	19	44.18%
Others	21	42%
Total	43	100%

The above table shows that among the 50 respondents 43 of them were engaged in the income generated activity. Out of the 43 respondents 44.18% of them were engaged in animal husbandry. Only 6.9% of them were engaged in cottage industries. The availability of natural resources, lack of materials and trainings are key factors for this variation.

TABLE 4: BACK ACCOUNT

Bank account	Number of respondents	Percentage
Yes	50	100%
No	0	0%
Total	50	100%

The above table shows the bank account of the respondents. All of them have bank account for their money transactions. The money transactions through bank account helped them to increase their savings. This is a progressive change in their life. Through this they get knowledge about modern transactions also.

TABLE 5: MONTHLY SAVINGS OF THE MEMBERS BEFORE AND AFTER JOINING IN THE SELF HELP GROUPS

Before Joining			After Joining		
Monthly Savings	Number of respondents	Percentage	Monthly Savings	Number of respondents	Percentage
Below 1000	20	86.95%	Below 2000	5	10%
Above 1000	3	13.04%	Above 2000	45	90%
Total	23	100%	total	50	100%

This table shows that the monthly savings of the members before and after joining in the SHGs. After joining SHGs almost all of them have savings and they use this savings for the development of the family. The analysis indicates that the economic condition had improved after joining the SHGs. Because the group following the system of compulsory savings. And they are engaged in various income generating activities.

TABLE 6: PROGRESS LEVEL IN SOCIO-ECONOMIC CONDITION OF THE RESPONDENTS AFTER JOINING IN SELF HELP GROUPS

Progress of Socio- Economic Conditions	Number of Respondents		Total
	Yes	No	
Standard of living	50(100%)	-	50
Annual income	43(86%)	7(14%)	50
Financial support to family	50(100%)	-	50
Self-sufficient for Income Generated Activity	43(86%)	7(14%)	50

In this analysis the table clearly reveals that the opinion regarding the progress in socio-economic conditions of the respondents after joining SHGs. All the respondents opined that their standard of living had improved after joining Self Help Groups. 86% respondents said that there is an increase in the annual income after joining in the SHGs and 100% of them were able to provide financial support in their family. 86% of them expressed that they were self-sufficient for doing their Income Generated Activity. They were not self sufficient before joining

in the SHGs. The analysis proves that there is a change in the socio-economic conditions of the women through SHGs. Compared with the past, majority of them had earned more benefits. After joining SHGs almost all of them have savings and they use this savings for the development of the family. The analysis indicates that the economic in condition had improved after joining the SHGs. Because the group following the system of compulsory savings. And they are engaged in various income generating activities.

TABLE 7: PROGRESS LEVEL IN SOCIO-ECONOMIC CONDITION OF THE RESPONDENTS AFTER JOINING IN SELF HELP GROUPS

Progress of Socio- Economic Conditions	Number of Respondents		Total
	Yes	No	
Standard of living	50(100%)	-	50
Annual income	43(86%)	7(14%)	50
Financial support to family	50(100%)	-	50
Self-sufficient for Income Generated Activity	43(86%)	7(14%)	50

In this analysis the table clearly reveals that the opinion regarding the progress in socio-economic conditions of the respondents after joining SHGs. All the respondents opined that after joining SHGs their standard of living changed. 86% respondents said that there is an increase in the annual income after joining in the SHGs and 100% of them were able to provide financial support in their family. 86% of them expressed that they were self-sufficient for doing their Income Generated Activity. They were not self sufficient before joining in the SHGs. The analysis proves that there is a change in the socio-economic conditions of the women through SHGs. Compared with the past, majority of them had earned more benefits.

TABLE 8: IMPROVEMENT IN POSITIVE THINKING

Improvement	Number of respondents		Total
	Yes	No	
Self respect	35(70%)	15(30%)	50(100%)
Social dignity	40(80%)	10(20%)	50(100%)
Self confidence	49(98%)	1(2%)	50(100%)
Self esteem	45(90%)	5(10%)	50(100%)

The table reveals through the participation in the SHGs their qualities like self respect, self dignity, self confidence and self esteem highly increased.

TABLE 9: PARTICIPATION IN SOCIAL EXTENSION ACTIVITIES

Extension Activities	Number of respondents		Total
	Yes	No	
Rising funds for the victims of natural calamities	49(98%)	1(2%)	50(100%)
Conducting sanitary programmes	44(88%)	6(12%)	50(100%)
Helping poor people in the village	28(56%)	22(44%)	50(100%)
Work for improvement of literacy of the group members	26(52%)	24(48%)	50(100%)
Organizing awareness classes	23(46%)	27(54%)	50(100%)
Motivating for collective thinking and action of the members	50(100%)	----	50(100%)

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The table reveals that around 98% of them said that they had participation in raising funds for the victims of natural calamities. 88% of them were interested in conducting sanitary programmes. 56% of them were organized programmes to help the poor people in the village. 52% of them were worked for improvement of literacy of the group members. 46% of the respondents said that they were organized awareness classes. All the respondents were motivated for collective thinking and action of the members.

TABLE 10: IMPACT OF PARTICIPATION

Impacts	Number of respondents			Total
	High	Average	Low	
Improvements in the quality of life	30(60%)	14(28 %)	6(12 %)	50(100 %)
Increases in the standard of living	29(58 %)	13(26 %)	8(16 %)	50(100 %)
Decision taking capacity	35(75 %)	15(25 %)	----	50(100 %)
Increases in the self managing capacity	32(64%)	8(16 %)	10(20 %)	50(100 %)

The table clearly indicates that they get certain impacts through participation. Regarding the improvement in quality of life of the respondents all of them were positively responded, within this 60% of them had high improvement. 58% of the respondents said that their living standard increased and 75% are able to take decisions, 64% expressed their self managing capacity increased.

TABLE 11: PROGRESS IN LEADERSHIP QUALITY

Progressive Changes	Number of respondents	Percentage
Yes	46	92%
No	4	8%
Total	50	100%

The study reveals majority of the respondent's changes of life style after joining the SHGs. Through this work they get good amount of money. This helped them to change their life style such as selection of dress, quality of food, celebrations in their family etc. It also helps to increase their status in the society.

TABLE 13: REGULAR MOBILE PHONE USAGES OF RESPONDENTS

Regular usages of mobile phones	Number of respondents	Percentage
Yes	41	82%
No	9	18%
Total	50	100%

The analysis shows 82 % respondents use the mobile phone regularly. Majority uses mobiles to communicate their group members. This helps them to convey their programmes. Regular use of mobiles shows their knowledge in modern facilities. This is absolutely true in the case of rural women.

MAJOR FINDINGS

- Economic empowerment and improvement in economic status.
- Social mobility increased through exposure to outside world.
- Developed team spirit and became organized group of employment.
- Improved sanitary conditions because of the construction of latrines.

- Habits of news paper reading and watching TV increased to get more information about day to day affairs and government programmes and policies.
- In the family decision making capacities increased and fairly attained equality in family matters.
- A large majority of the respondents stated that they are to take independent decisions on various family matters and also implemented them.
- Over all positive changes in the life style such as proper food habits, education of children, personal hygiene etc enhanced.
- They participated in extension activities like raising funds for the victims of natural calamities, conducting sanitary programmes, helping poor people in the village, work for improvement of literacy of the group members, organizing awareness classes. These activities lead to motivating the members towards collective thinking and action.
- Majority of them (88%) improved their quality of life.
- ❖ Their economic independence has elevated their level to involve them in the developmental activities in the village.
- ❖ Majority of them raised their saving habit and self management created self reliance through the participation of the SHGs.
- ❖ All of them actively participating in the rural welfare activities after becoming the member of SHGs.
- ❖ They participating in the managing issues such as water, sanitation, health and family welfare issues etc.
- ❖ Due to the impact of participation their social skills have been improved and their awareness has risen. Majority of the respondents' conscious about the social issues through the discussions, debates, readings awareness classes organized for SHGs.
- ❖ 96% of the respondents attended the training programmes and awareness classes.
- ❖ Awareness about schemes and subsidies of Government, reservation policies and rights of women had increased.
- ❖ Respondents get more social benefits and gained the knowledge about the banking system and development programmes. The group interaction, saving habits, mutual dependency, and economic independence decision making process were increased.
- ❖ All the respondents opined not only Government but non-Governmental bodies were also given full support to them.
- ❖ Voluntary organizations were acting as the promoters, trainers and executors to facilitate group activities.
- ❖ The above analysis proves that the socio-economic conditions of the respondents, the participation and awareness of the respondents were improved through the participation in SHGs. All the respondents are very satisfied about being members of the group.
- ✓ Membership in SHGs empowering helps the respondents.
- ✓ Majority of the respondents belonged to below 50 years of age.
- ✓ Majority of them were engaged in income generated activities like animal husbandry and others like textile business and marketing few of them engaged in cotton industries.

- ✓ Majority of them earned high monthly income from income generated activity
- ✓ The respondents who have high school education and above had actively participated in the better income generated activities.
- ✓ The younger and educated respondents actively participated in the SHGs.
- ✓ Majority of them have savings for the progress of their family.
- ✓ Their annual income increased and they become self sufficient to do their own works.
- ✓ All (100%) respondents became capable to financially assist their family.
- ✓ The younger and educated respondent performed main roles like president, secretary and treasurer.

SUGGESTIONS

- Training in non-traditional activities has to be given.
- The Voluntary organizations and government should take necessary steps for marketing the goods produced by the SHGs.
- Frequent awareness camps can be organized by the Rural Development Department authorities to create awareness about the different schemes of assistance available to the participants in the Self Help Groups.

CONCLUSION

The self help groups in the Mala Panchayath playing an important pivotal role in social transformation, welfare activities and infrastructure building and they have served the cause of women empowerment, social solidarity

and socio-economic betterment of the poor. SHGs, a mini voluntary agency for social help at the micro level has been a focus on the weaker sections particularly women for their social defence. SHGs has got great potential in creating awareness on day today affairs, promoting in savings habit, developing self and community assets, increasing the income level, increasing the social power and development. In short the empowerment of women through SHGs would lead to benefits not only to the individual woman and women groups but also the families and community as a whole through collective action for development.

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