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Botany & Zoology

Plant Species Composition

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Highlights

The Expansion of Production

Development of Chitosan Membranes

Discovering Thoughts, Inventing Future

VOLUME 17 ISSUE 2 VERSION 1.0

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Insect Biodiversity of Mahapoli Village of Bhiwandi Taluka, District Thane

By Patel Naziya & Nisar Shaikh
G. M. Momoin Womens college Bhiwandi

Abstract- The diversity and ecological importance of insects makes them very valuable for studies of biodiversity. Insects play a huge role inlives of man. Survey of Insect Biodiversity are undertaken to find out the organisms exist in a given area. The survey was carried out in Mahapoli village for the study of the ecological significance of the Insects. Insects may be found in nearly all environments, although only a small number of species reside in the oceans, a habitat dominated by another arthropod group, crustaceans. Insect bring both joy and sorrow. Their importance to human welfare transcends the grand battles. Most of us hate them, but some of us love them. Indeed at times they even inspire us. It is necessary to protect them.

Keywords: *biodiversity, insect, mahapolivillage.*

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Insect Biodiversity of Mahapoli Village of Bhiwandi Taluka, District Thane

Patel Naziya [α] & Nisar Shaikh [σ]

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Keywords: biodiversity, insect, mahapolivillage.

I. Introduction

Insects are the largest and most diverse class of animals on earth. Insects which account for over half of all living described organisms (Wilson, 1988; Chapman, 2006) have a very significant role in the ecosystem by affecting the diversity, abundance and distribution of plant communities. According to Wiggins (1983) and Finnamore(1996a)there are about 751,000 known species of insects, which are about three-fourths of all species of animals on the planet. Insects are extremely diverse and important to ecosystems. Ourpresent ecosystems would not function without insects said by Wiggins et al.,(1991).

Many insects are valuable to humans, for example by their pollinating activities. Berenbaum et al., (2006) noted that bees are of the most economically important groups of insects as a result of pollination of agricultural crops. Furthermore, some of the insects also provide us with honey, silk and other commercial value products; they serve as food for bird, fish and beneficial animals; they perform valuable services as scavenger, and they have been useful in medicine and scientific research was investigated by Triplehorn et al., (2005). But, some of them are harmful and become pests in agricultural crops and stored products, and some insects transmit diseases to human and other animals. Schwalter(2006)investigated insect ecology is the scientific study of how insects, individually or as a community, interact with the surrounding environment or ecosystem. Insects have immense capacity of adaptations to extreme environments than any other animal groups. As in lowland ecosystems, even at high altitudes, insects are the dominant animals. Insects successfully dominant almost every conceivable habitat and flourish at the highest limits of existence of animal life. According to Holldobler, Wilson (1994) many other insects are considered ecologically beneficial as predators and a few provide direct economic benefit. According to author insects play one of the most important roles in their ecosystems, which includes many roles, such as soil turning and aeration, dung burial, pest control, pollination and wildlife nutrition(Gullan2005). Dossey(2010) stated that recently insects have also gained attention as potential sources of drugs and other medicinal substances. Sherman et al., (1987) investigated that adult insects, such as crickets and insect larvae of various kinds, are also commonly used as fishing bait. Because of their many roles, they are familiar to the general public. However, their conservation is a challenge.

II. The Objectives

The following objectives were set forth for the present study:

- To assess the diversity of insects.
- To determine the status and distribution of different insects groups in the village particularly.

III. The Study Site – Mahapoli Village

The present study was undertaken in the Mahapoli village. Mahapoli is a village panchayat located in the Thane district of Maharashtra state, India. The district is situated between 18° 42' and 20°20' north latitudes and 72°45' and 73°48'east longitudes. The latitude 19.4010673 and longitude 73.0847979 are the geo-coordinate of the Mahapoli. It is located around 56.40kmaway from Mumbai.

IV. Climatic Conditions in Mahapoli

The micro climate of area is sum of the metrological and topographical condition that determines the average state of surrounding. The precipitation in Mahapoli is moderate throughout the year and abundant during the monsoon month (June to September). The winter month starts from October to January.

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V. Material and Methods

This study was conducted at Mahapoli Village from the 5th February until 20th February 2017. Data collection was done by taking the photographs of insectsfrom 9.00 am to 7.00 pm.

VI. Result and Discussion

According to the calculations, Shannon index is equal to 1.796. During field visits, similar types of insects were found at each location. At stations 1, 6 and 15 there were maximum population of insects (fig.1 and 2). In this study, a total of 377 individual of insects from 9 Orders were collected. They are from the Order of Diptera, Hymenoptera, Lepidoptera, Odonata, Orthoptera, Coleoptera, Hemiptera and Blattodea (Table 1 and 2). From 32 collected Families. Of these, only 9 Families were recorded at all zone sites. The results show that Hymenoptera (32.63%) were the most dominant insects in the village, followed by Diptera (30.50%) and Odonata (11.67%). The rarest insect Order were Dermaptera, Hemiptera and Blattodea that is, lower than 3% (Table 2). However, one of the 9 identified Orders was spatially rarest Order. It is Dermaptera, with collection of only four specimens (1.06%) throughout this study (Table 2). Of the collected insects, the Order Hymenoptera has the highest diversity in the village. This is because majority of the trees were in zone.

Table 1: Insect diversity

Insects order / Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	ni
Diptera	11	9	3	7	0	8	22	17	6	3	0	13	1	9	6	115
Hymenoptera	27	1	0	0	2	31	4	7	12	0	0	1	5	4	29	123
Lepidoptera	2	4	1	1	1	5	3	1	1	0	2	1	3	2	2	29
Odonata	7	3	3	2	2	1	4	5	5	1	0	1	3	4	3	44
Orthoptera	1	1	4	2	2	2	0	2	3	1	3	0	2	2	1	26
Coleoptera	2	1	1	1	0	0	2	2	2	1	2	1	1	1	1	18
Hemiptera	0	0	1	0	0	0	2	1	1	0	0	0	1	1	0	7
Blattodea	1	0	0	5	0	0	0	1	0	2	0	0	0	0	2	11
Dermaptera	0	0	1	0	0	1	0	0	1	0	0	0	1	0	0	4
Total	51	19	14	18	7	48	37	36	31	8	7	17	17	23	44	377

Table 2: Diversity indices

Order	Total No of the Insects (ni)	Total No of the Family	Percentage (%)	Pi	Diversity index (H)	D	Evenness index (E)
Diptera	115	2	30.50	0.411	0.365	0.168	
Hymenoptera	123	3	32.63	0.326	0.365	0.106	
Lepidoptera	29	8	7.69	0.076	0.195	0.005	
Odonata	44	4	11.67	0.116	0.249	0.134	
Orthoptera	26	3	6.89	0.068	0.182	0.004	
Coleoptera	18	5	4.77	0.048	0.145	0.002	
Hemiptera	7	4	1.86	0.18	0.072	0.032	
Blattodea	11	1	2.92	0.029	0.102	0.0008	
Dermaptera	4	2	1.06	0.037	0.121	0.001	
Total	377	32	100	-	H=1.796	D=0.452	E=0.8010

Results of this study show that this village has high diversity and abundance of insect fauna. The majority of insects found in this village were Hymenoptera. This is because the most area of village has diverse vegetation and habitats. The vegetation's diversity and richness indirectly affect insect species diversity and abundance. Abdullah et al., (2009) noted that the structure of vegetation between the different sites could be affecting the existing of insect diversity. This study also showed that insect species diversity and abundance are significantly different among sites. We recorded 51 insects at site 1, 48 at site 6 and 44 at site 15 during the investigation period. The vegetation structure at site 1, 6 and 15 mostly consists of higher plants and different kinds of trees. According to Nummelin (1996) and Wardle et al., (1997) low and high temperature, rainfall and vegetation cover have been reported to influence the population density of insects. The village has diverse topography, vegetative features and climate which directly affect the diversity and occurrence of insect species. These needs will comprise, at the very least, food and suitable climatic conditions, and may also include shelter from disturbance and natural enemies said by Uniyal et al., (1998).

We sampled the area for the period of less than one month during winter season. We feel that our visits were less as compared to those required for insect

diversity studies. Rainy season is considered as best season for insect study. Therefore there is a possibility of getting more diversity of insect if the study is done during the monsoon season and study time is increased. Hopefully, there will be a further research study on the insect biodiversity and taxonomy in this area, in order to get better and comprehensive information on those aspects to be documented for future reference.

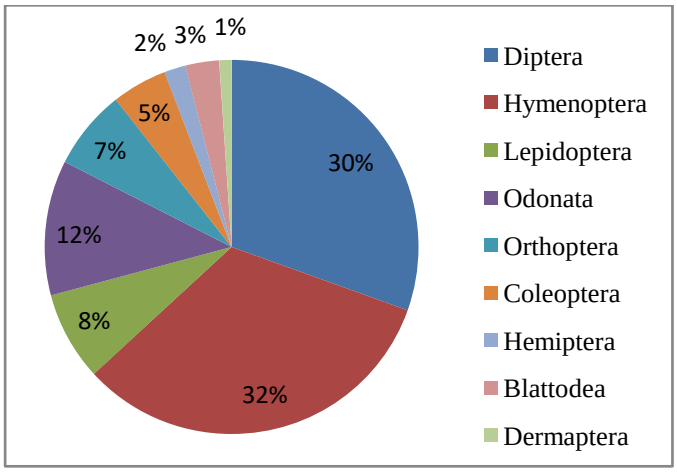

Fig. 1: Percentage (%)wise distribution of insects

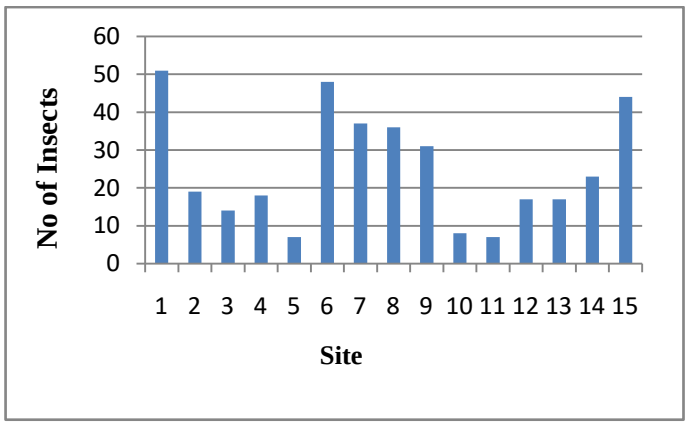

Fig. 2: Site wise distribution of insects

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Development of Chitosan Membranes Containing Photosensitizer for Water Disinfection

By Cintia Ramos Camargo, Virginia da Conceição Amaro Martins, Ana Maria de Guzzi Plepis & Janice Rodrigues Perussi

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Abstract- Chitosan membranes with a photosensitizer incorporated were developed for the photoinactivation of bacteria in drinking water. The photosensitizers incorporated into chitosan membranes were methylene blue, rose Bengal and two porphyrins: 5,10,15,20-tetrakis(p-aminophenyl)-porphyrin (p-TAPP) and meso-tetrakis(4-N-metylpyridyl)-porphyrin (TMPyP). Evaluation of photoactivity against *Escherichia coli* suspensions (1×10^7 cells mL^{-1}) showed that both porphyrins had a considerable bactericidal effect under irradiation at 590 nm (2 log reduction in 120 min for p-TAPP and 4 log reduction in 140 min for TMPyP) or 452 nm (2 log reduction for p-TAPP and 4 log reduction for TMPyP in 120 min). Therefore photoinactivation was most effective for TMPyP when blue light was used, leading to a greater reduction in cell count in a shorter period. These results suggest that photoinactivation is effective with either porphyrin incorporated in a polymeric support and that this system has potential to eliminate microbial contaminants in water.

Keywords: *chitosan; membrane; photosensitizer; disinfection.*

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Keywords: chitosan; membrane; photosensitizer; disinfection.

I. Introduction

Chemical processes are the most widely used methods of drinking water disinfection; however, modern analytical methods for water analysis have revealed by-products that are toxic and potentially carcinogenic[1, 2]. Photodynamic inactivation (PDI) seems to be a very promising method to inactivate microorganisms in water without the formation of hazardous compounds[3-5]. PDI utilizes photosensitizers and light to promote a rapid phototoxic effect, normally oxidative, which is capable of damaging biomolecules and cellular structures and thus killing microorganisms[6-8]. However, the photosensitizer must not persist as a contaminant. One way to solve this problem is to immobilize the photosensitizer in a polymeric support. Interest in polymers containing photoactive groups results from their broad applications, as drug carriers, sensors, sensitizers[9-11] and (in the environmental field) for water purification[9, 12]. Due to environmental concerns, there is interest in developing such a system using natural polymers[13].

In this context, chitosan, a non-toxic, biocompatible and biodegradable polysaccharide obtained by N-deacetylation of chitin, appears to offer a number of distinct advantages. One of the most abundant polysaccharides in the biosphere, chitin is a low-cost source material, obtained from crustaceans, molluscs, insects, mites, fungi and algae[14]. However, chitin is insoluble in water and organic solvents, which makes it difficult to use. Chitosan, however, is more suitable for biological applications[15]. Chitosan is insoluble in water, concentrated acids, alcohol and acetone; however, it is freely soluble in solutions of weak organic acids (acetic, formic and citric acid) and diluted inorganic acids (hydrochloric, nitric, perchloric or phosphoric acid)[16, 17]. The main characteristics that make chitosan of great interest for a large number of applications are the potential for chemical modification, or for being prepared in different forms such as solutions, sponges, films, membranes and gels[17]. Furthermore, the antimicrobial activity of chitosan and its derivatives have been widely studied, with good inhibitory activity against bacteria, fungi and yeasts[18, 19]. These effects are influenced by the physical characteristics of the preparations (such as the degree of deacetylation and molecular weight), as well as by concentration, exposure time, viscosity and pH[20, 21].

Applications for biomaterials obtained from chitosan have evolved over the last decade. Properties such as biocompatibility and biodegradability allow several applications for these biomaterials. The versatility of chitosan enables its use in agriculture, food processing, tissue engineering, and the pharmaceutical, medical and dental areas[17, 22, 23]. Chitosan can capture metals and flocculants to purify and clarify water[17, 24-26]. For water disinfection, Bonnett et al, 2006[27] proposed the use of chitosan as a polymeric support for PDI because chitosan is water-insoluble, promoting contact between the membrane-bound photosensitizer and the aqueous suspension of microorganisms[28].

Therefore, the goal of this study was the incorporation of photosensitizers into chitosan

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membranes, for use in the microbiological disinfection of water.

II. Materials and Methods

a) Chemicals and preliminary characterization of the chitosan sample

Chitosan was obtained by deacetylation of β-chitin, from pens of Loligo sp[29]. The degree of acetylation of chitosan was determined by conductimetric measurements. Molar mass was determined by viscometric measurements[30]. The commercially available photosensitizers methylene blue (MB, Sigma Aldrich- USA), rose bengal (RB, Vetec Química-Brazil), meso-tetrakis(4-N-methylpyridyl)-porphyrin (TMPyP, Midcentury Chemicals, USA) and 5,10,15,20-tetrakis(p-aminophenyl)-porphyrin (p-TAPP, Sigma Aldrich, USA) were used without further purification. The chemical structures of the photosensitizers are shown in Fig. 1. All other reagents used in this study were of analytical grade.

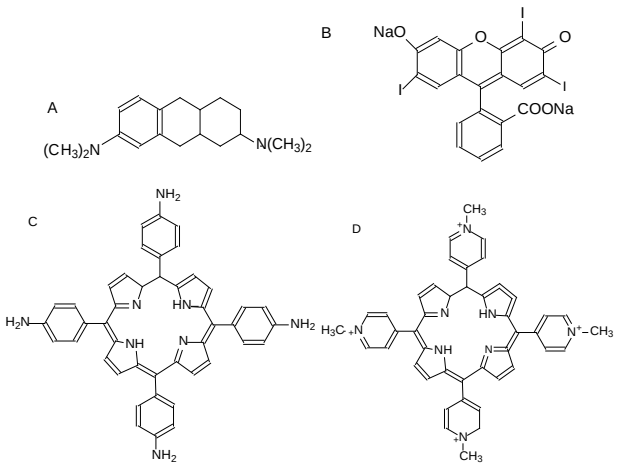

Fig. 1: Chemical structure of MB (A), RB (B), p-TAPP (C) and TMPyP (D).

b) Preparation of the chitosan membranes

The stock of chitosan was prepared at a concentration of 1% (w/w) in acetic acid. Ten grams of chitosan gel was placed in a Teflon® tray4.7 × 4.7 × 0.7 cm. The trays were kept in a chamber with air flow for three days. When submerged in water (Milli-Q), chitosan membranes with photosensitizer swelled and began to fragment. Sodium tripolyphosphate (TPP) is a crosslinking agent that interacts with chitosan via electrostatic forces, forming a network of ionic crosslinks that inhibit its dissolution[31, 32]. Therefore chitosan membranes with and without photosensitizer were treated with 0.5% (w/w) of TPP in 2 mol L^{-1} NaOH for 30 minutes in order to stabilize the material against fragmentation and swelling. The membranes were then washed, dried and stored at room temperature (25°C).

c) Preparation of chitosan membranes with incorporated photosensitizer

A stock solution of each photosensitizer at a concentration of 1 mg mL^{-1} in ethanol was prepared and stored in the dark at 4°C for up to seven days. Each photosensitizer solution (1 mL) was added to 15 g of chitosan gel (1% (w/w) in acetic acid). The mixture was homogenized and then treated as described under "preparation of the chitosan membranes". After drying, the photosensitizer not immobilized in the membranes was released. Membranes (22 cm^2) containing photosensitizer were placed in 200 mL of distilled water under mechanical agitation for three days or until no more photosensitizer was observed by spectroscopy (600, 565, 416 or 425 nm, for AM, RB, p-TAPP or TMPyP, respectively). The membranes were then air-dried. The concentration of photosensitizer in the chitosan membrane was estimated by UV-Visible Spectroscopy at the above wavelengths[27].

d) Fourier transform infrared spectroscopy (FT-IR)

To obtain FT-IR spectra, samples of chitosan (1% w/w) with and without photosensitizer were prepared in 1% acetic acid, transferred to a silicon support and oven dried under vacuum. IR spectra were obtained in a Bomen MB-102 at 400 to 4000 cm-1 with 32 scans.

e) Microorganisms and preparation of cell suspension

Escherichia coli (ATCC 25922) was kindly provided by Prof. José Francisco Hoffling, Department of Oral Diagnosis, UNICAMP. A suspension of *E. coli* containing 1×10^9 cells mL^{-1} was prepared after growing in Brain Heart Infusion Agar (BHI, Oxoid, São Paulo, Brazil) in an incubator (002 CB Model - Fanem, São Paulo, Brazil) for 48 h at 37°C. Then, the bacterial suspension was inoculated in Luria-Bertani Broth (LB, Oxoid, São Paulo, Brazil) and maintained at 37°C for 18 h in an orbital shaker (Marconi MA 410, Piracicaba, Brazil) at 100 rpm. After the incubation period, a pellet was obtained by centrifugation (Excelsa II - Fanem, São Paulo) at 1300 rpm for 10 minutes and suspended in 10 mL of sterile saline. This procedure was repeated two

more times. Counting of cells in the suspension was performed using a spectrophotometer at 590 nm (Hitachi U2800, Japan).

f) Light source and photoinactivation setup

Photoinactivation of the bacteria was evaluated by exposing the membranes to a series of LEDs (BioTable).Blue LEDs (452 ± 30 nm) were used to irradiate the porphyrins only, yellow (590 ± 30 nm) to irradiate rose bengal and porphyrins, and red (630 ± 30 nm) to irradiate methylene blue, based upon the maximum wavelengthof each photosensitizer. The fluence rate of the blue LED was 14 mW cm^{-2}, yellow 10 mW cm^{-2}, and red 18 mW cm^{-2}.

The photocytotoxicity of the four immobilized photosensitizers towards *E. coli* in water was assessed by incubating the chitosan membranes with the bacterial suspension, followed by irradiation with the appropriate LED for different time intervals (20, 40, 60, 80, 100, 120, 140, 160 and 180 min). Chitosan membranes with MB were irradiated with red LEDs; those with RB, p-TAPP or TMPyP were irradiated with yellow LEDs. The porphyrins were also irradiated with blue LEDs because these photosensitizers also absorb these wavelengths.

Membranes (1 cm^2) were placed in a 24-well polystyrene plate (Corning Costar) and submerged in bacterial suspension (1.2 mL, 1×10^9 cells mL^{-1}). Aliquots of 0.1 mL were removed, and the number of colony-forming units per millilitre (CFU mL-1) determined. Control experiments were performed on chitosan membranes both without photosensitizer under irradiation and with photosensitizer in the dark. For each membrane in each experimental condition, three independent experiments were performed and the results presented as the average of the three assays.

III. Results and Discussion

a) Chitosan membranes

The degree of acetylation of chitosan was determined by conductimetric measurements to be 9%. Viscometric measurements were used to estimate the molar mass as 1.248 x 10^5 g mol^{-1}.

Four photosensitizers from different classes (two porphyrins, one phenothiazine and one halogenated xanthene) were incorporated into chitosan membranes. Chitosan membranes prepared without photosensitizer (CH) were translucent, with a thickness of ~60.0 μm. Membranes with MB (CHMB), RB (CHRB), p-TAPP (CHpTAPP) and TMPyP (CHTMPyP) were blue, pink, light brown and light yellow, respectively.

Chitosan gel with and without photosensitizer was characterized by FT-IR. Spectra obtained with or without photosensitizer are shown in fig. 2. We assign the absorption bands as follows: 1550 cm^{-1} - angular deformation of N–H (amide II); 1150 cm^{-1} - axial deformation of O–H in the hydrogen bond; 1600-1670 cm^{-1} - C=O stretch of amide I, because chitosan is not completely deacetylated; 800-1200 cm^{-1} - pyranoside ring[33-36]. FT-IR spectra were similar with or without photosensitizer, but the amino group peaks (amide I) of chitosan with photosensitizer (MB, RB, p-TAPP and TMPyP) were shifted to lower wavenumbers, suggesting an interaction with the photosensitizers.

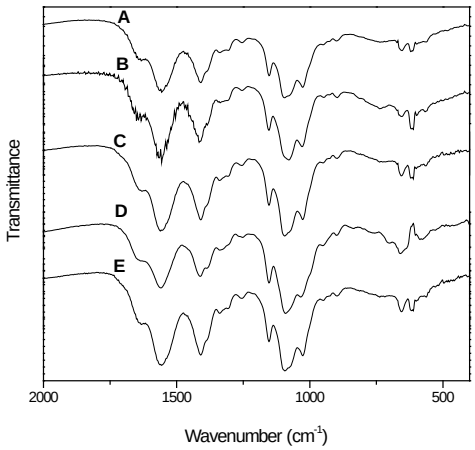

Fig. 2: Infrared spectra of chitosan membranes with no photosensitizer (A), AM (B), RB (C), p-TAPP (D) or TMPyP (E).

To ensure that photosensitizer would not be released from the membranes during PDI experiments, liberation of the photosensitizer not immobilized in chitosan membranes was performed. After these procedures, part of the membrane was used in photoinactivation assays, and part was used to determine the final concentration of photosensitizer incorporated into the membrane.

Because the photosensitizers are attached to chitosan membranes, which are insoluble in water, one cannot directly compare their spectroscopic properties with free photosensitizer molecules. For this purpose, the absorption spectra of the chitosan membranes with photosensitizer were obtained by dissolving in 1% (w/w) acetic acid and compared to spectra of the photosensitizer alone in 1% acetic acid.

The spectrum of CHMB showed maximum absorbance at approximately 600 nm, compared to 665 nm for MB in acetic acid (Fig. 3a). This indicates aggregation of AM-forming dimers[37, 38]. The formation of aggregates may reduce the efficiency of the photosensitizer because no radioactive decay occurs by internal conversion, making it difficult to transfer energy to ground-state oxygen[39, 40]. From the absorbance at 600 nm, a rough estimate may be given that the MB content in the membrane was approximately 5 μmol L^{-1} MB per gram of chitosan membrane. The estimate of the concentration of photosensitizer in the membranes is rough because the molar extinction coefficient is dependent on solvent composition[12]. It is not possible to compare this result with values from the literature because the applications for which the membranes were developed were different. Previous studies in our group incorporating MB into polymeric supports such as collagen-based membranes have estimated MB content from the concentration released versus time of incubation in artificial saliva. This allowed us to evaluate the photodynamic effect against *Candida albicans*[41].

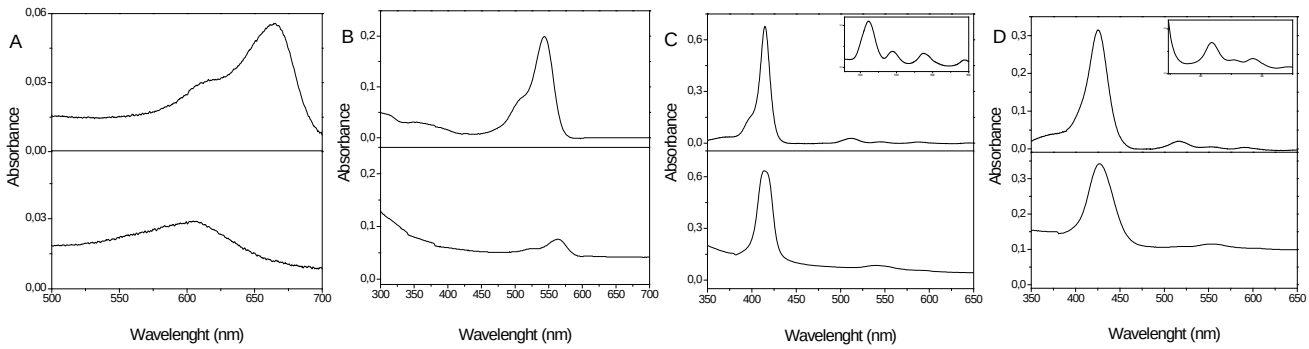

Fig. 3: Absorption spectra of MB (A), RB (B), p-TAPP (C) and TMPyP (D) photosensitizer solutions in 1% acetic acid (upper graph) and dissolution of chitosan membranes with photosensitizers in 1% acetic acid (bottom graph). The inserts in graphs C and D show an expansion of the Q-band of porphyrin in ethanol

Fig. 3b shows that the spectra obtained from the dissolution of the CHRB membrane and those of the solution of RB in 1% (w/w) acetic acid exhibited maximum absorbances at approximately 554 and 565 nm, respectively. This indicates a small red-shift due to a change in environment (bathochromic shift)[27]. A rough estimate of RB concentration in chitosan membranes from 565 nm was approximately 3.5 μmol L^{-1} RB per gram of chitosan membrane. Again, these results cannot be compared with those reported in the literature. In studies using chitosan and RB, chitosan chains were modified by covalent attachment of RB. Thus RB was attached to the polymer chain and not adsorbed, as in this study[12, 42]. Other studies that use RB employ polystyrene as the polymeric support. The mechanism of action using this support is not acceptable for the disinfection of water because the photodynamic effect is mediated by the slow release of RB into the cell suspension[43].

As shown in Fig. 3c, a Soret band (at 416 nm) was observed in both spectra of the p-TAPP (dissolved CHpTAPP membranes and p-TAPP solution). In the dissolved CHpTAPP spectrum, a small red shift of the Q-band (500-600 nm) was observed. From the absorbance at 416 nm it was estimated that approximately 1 μmol L^{-1} p-TAPP per gram of chitosan membrane remained embedded. The results in the literature show that approximately 5 mg cm^{-2} of p-TAPP was incorporated into chitosan membranes when 7.5 mg cm^{-2} was added to the chitosan gel before drying. Therefore the incorporation efficiency was 67%[27], much higher than that obtained in this study (1.5%).

TMPyP spectra (Fig. 3d), obtained by CHTMPyP dissolution and in solution, showed a Soret band at 425 nm. Again a small red shift of the Q-bands (500-600 nm) is seen in the TMPyP spectrum of dissolved membranes. From the absorbance at 425 nm, it was estimated that 2 μmol L^{-1} TMPyP remained incorporated per gram of chitosan membrane. To our knowledge there is no prior study in the literature using TMPyP incorporated into a polymeric support.

Quantification of the four photosensitizers in chitosan membranes suggest that a small proportion of the photosensitizers was retained on the polymeric support. Retention of photosensitizers in polymeric membranes depends on the concentration and chemical structure of photosensitizer, and on the nature of the polymer[27, 41, 44].

Furthermore, our results suggest that in developing membranes for use in water disinfection, prior release of the photosensitizer not immobilized in the membranes is important to ensure the absence of the photosensitizer from the treated water[45].

b) Photoinactivation of Escherichia coli

Control membranes, kept either in the dark with photosensitizer or exposed to light without photosensitizer, did not cause a significant decrease in *E. coli* count (Fig. 4, 5 and 6). This indicates that the reduction in cell survival after irradiation was due to photoinactivation.

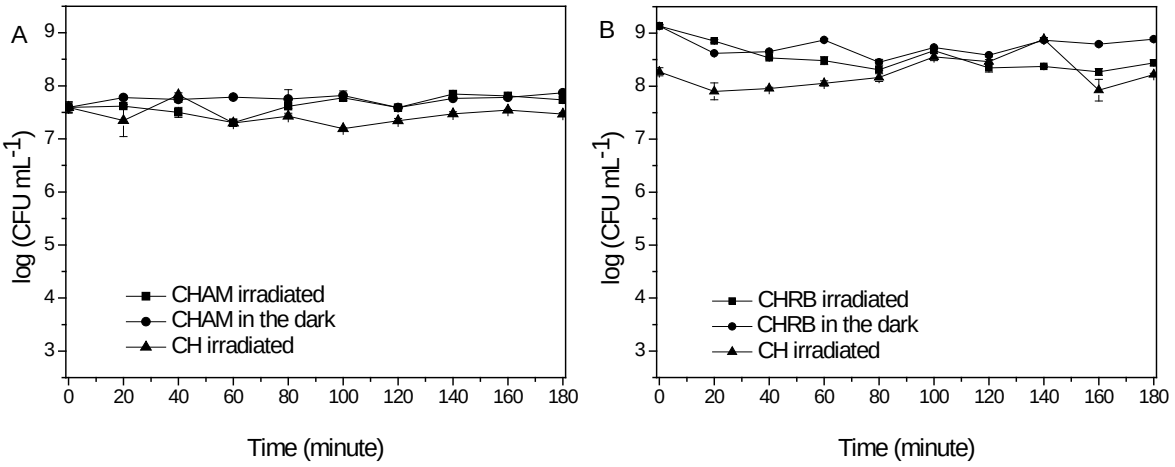

Fig. 4: Viability of *Escherichia coli* in the presence of chitosan membranes incorporating MB (A) or RB (B) exposed to red LED and yellow LED, respectively, and control membranes (irradiated without photosensitizer, and with photosensitizer in the dark). Points represent the average of two independent experiments

The results obtained in the PDI experiments using *E. coli* are summarized in Figs. 4-6. CHRB and CHMB did not cause a significant decrease in bacterial cells after irradiation (Fig. 4). There are some reports that MB (3.65 μmol L^{-1}) and RB (3.0-10.0 μmol L^{-1}) solutions significantly reduce *E. Coli* count[46-48]. This indicates that photodynamic inactivation was not effective using CHMB (5 μmol L^{-1} per gram of chitosan membrane) or CHRB (3.5 μmol L^{-1} per gram of chitosan membrane). This may be due to the low rate of singlet oxygen production by photosensitizers immobilized on polymeric supports. This rate is about one hundred times lower than that of photosensitizers in solution[49, 50]. Moreover, the formation of aggregates in the CHMB membranes may also have contributed because the formation of aggregates decreases the photodynamic efficiency of the photosensitizer[39].

However, chitosan membranes with porphyrins were effective against the bacteria. CHpTAPP membranes caused an approximately 2 log reduction in cell survival after 140 min of exposure to yellow or blue LEDs (Fig. 5 *a* and *b*, respectively). CHTMPyP membranes caused a 4 log reduction after 140 and 120 min irradiation with yellow (Fig. 6a) and blue (Fig. 6b) LEDs, respectively. These results suggest that CHpTAPP and CHTMPyP membranes have significant photodynamic activity even against concentrated bacterial suspensions (1×10^9 cells mL^{-1}). Literature results[27] indicate a significant reduction in cell count when using higher concentrations of p-TAPP incorporated in chitosan and an initial bacterial concentration of 3.5×10^3 cells mL^{-1}. Thus, the present results suggest that chitosan membranes containing p-TAPP have photodynamic activity even against concentrated bacterial suspensions.

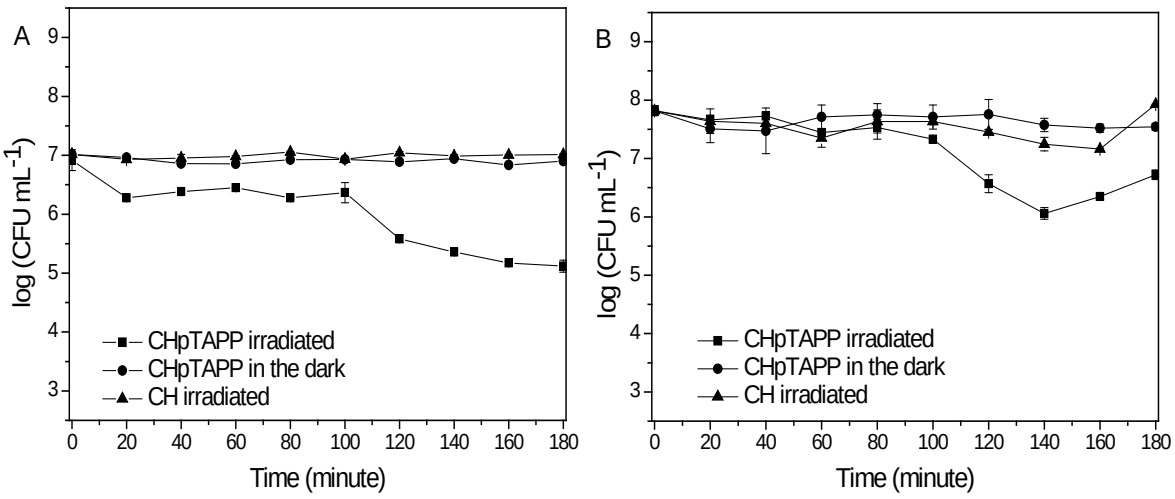

Fig. 5: Viability of *Escherichia coli* in the presence of chitosan membranes incorporating p-TAPP exposed to yellow (A) and blue (B) LEDs and control membranes(irradiated without photosensitizer, and with photosensitizer in the dark). Points represent the average of two independent experiments

In irradiating CHTMPyP with blue LEDs, we observed the same cell count reduction (4 log) at 120 minutes as with yellow LEDs. As shown in Fig. 3d, the TMyP molar extinction coefficient is greater in the blue region than in the yellow region, leading to higher absorption of light. This in turn leads to an increased production of oxidative species, giving the porphyrin better photodynamic activity when irradiated in the blue region[7].

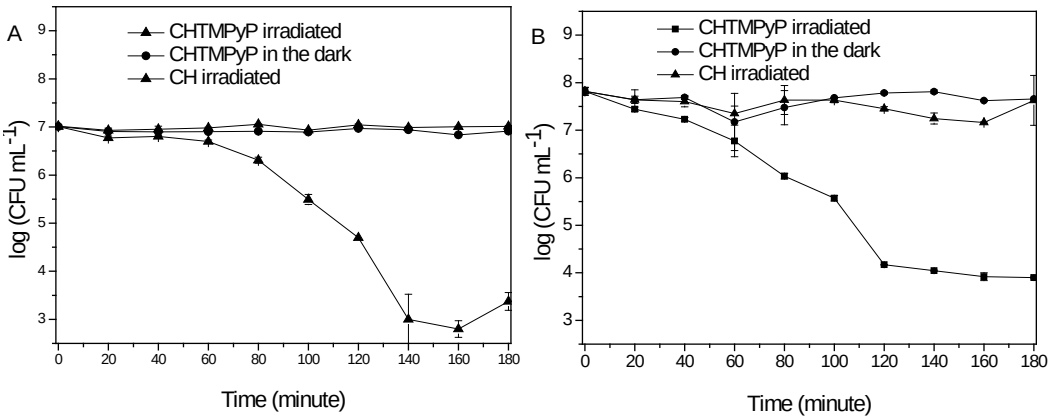

Fig. 6: Viability of *Escherichia coli* in the presence of chitosan membranes incorporating TMPyP exposed to yellow (A) and blue (B) LEDs and control membranes (irradiated without photosensitizer, and with photosensitizer in the dark). Points represent the averages of two independent experiments.

It can be observed in Table 1 that the concentration of photosensitizer remaining embedded in the polymeric carrier is not a limiting factor for the photodynamic process because the p-TAPP incorporated in lower concentrations (i.e., 1 μmol L^{-1} p-TAPP per gram of chitosan membrane) produces a photodynamic effect, while MB at 5 μmol L^{-1} per gram of chitosan was not able to inactivate the bacteria. Furthermore, the ionic charge of the molecule and the quantum yield of singlet oxygen are factors that contribute to photoinactivation of *E. coli*. For example, TMPyP is tetra-cationic, and has a quantum yield slightly lower than RB, which is di-anionic. TMPyP showed greater photodynamic activity on the Gram-negative bacteria employed (Table 1). These results agree with other studies using photosensitizer in solution[46, 47, 51, 52], which suggests that photoinactivation depends on concentration, quantum yield of singlet oxygen and the ionic charge of photosensitizers. Furthermore, these results also suggest that Gram-negative bacteria (such as E. coli) are more easily photoinactivated by cationic photosensitizers. A paper of our group in which the efficacy of the developed collagen membranes with these porphyrins incorporated was tested for photoinactivation of microorganisms in circulating water has been published elsewhere[53].

Table 1: Summary of results and properties of photosensitizers

Photosensitizer	TMPyP	p-TAPP	RB	MB
Immobilized photosensitizer concentration	2	1	3	5
(μmol L^{-1}/ gram of chitosan membrane)				
Produces photodynamic effect	Yes	Yes	No	No
Ionic charge	4+	0	2-	1+
Quantum yield of singlet oxygen	0.74[53]	0.53[54]	0.76[55]	0.39[56]

IV. Conclusions

The development of chitosan membranes incorporating photosensitizers was investigated for the photoinactivation of the bacterium *Escherichia coli*. Only a small proportion of the photosensitizers was immobilized on the chitosan membranes. Furthermore, it is important to remove non-immobilized photosensitizers from the polymeric support, because residual traces of photosensitizer are unacceptable in water disinfection. It was observed that the photodynamic inactivation process depends on the ionic charge as well as the spectroscopic and photophysical properties of the photosensitizer. TMPyP incorporated in chitosan membranes was the most effective in inactivating *E. coli*, and thus shows the one with better potential to inactivate bacterial water contaminants. This is of great importance because water disinfection using immobilized photosensitizers may have significant practical applications. These

include the purification of water tanks in hospitals, dental offices, schools and homes, being a promising approach to avoid the eventual recontamination of water seen after traditional methods of disinfection.

V. Acknowledgements

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Zooplankton Seasonal Abundance in Relation to Physico-Chemical Features in Mahapolilake, Bhiwandi, Maharashtra

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Abstract- Physico-chemical analysis and zooplankton survey of the Mahapoli Lake was carried out on monthly basis for the period of one year from February-2016 to January-2017. PH determined alkaline nature of the lake ranging 7.2 to 7.9, Dissolved oxygen 4.2-7.77mg/l was recorded. Alkalinity (97 to 183mg/l), total Hardness (69 to 142 mg/l), chlorides (45 to 63 mg/l) and the nutrients like phosphates and nitrates were at maximum in summer and minimum in rainy season. During the study period, total 10 species of zooplankton were identified by three groups such as Rotifera (4sp), copepoda (3sp) and cladocera (3sp).The highest numbers of zooplanktons were recorded in summer months and lowest in rainy season.

Keywords: *physico-chemical, zooplankton, rotifera, cladocera, copepoda, mahapoli village.*

GJSFR-C Classification: *FOR Code: 039999*

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Zooplankton Seasonal Abundance in Relation to Physico-Chemical Features in Mahapolilake, Bhiwandi, Maharashtra

Patel Naziya [α] & Nisar Shaikh [σ]

Abstract- Physico-chemical analysis and zooplankton survey of the Mahapoli Lake was carried out on monthly basis for the period of one year from February-2016 to January-2017. PH determined alkaline nature of the lake ranging 7.2 to 7.9, Dissolved oxygen 4.2-7.77mg/l was recorded. Alkalinity (97 to 183mg/l), total Hardness (69 to 142 mg/l), chlorides (45 to 63 mg/l) and the nutrients like phosphates and nitrates were at maximum in summer and minimum in rainy season. During the study period, total 10 species of zooplankton were identified by three groups such as Rotifera (4sp), copepoda (3sp) and cladocera (3sp).The highest numbers of zooplanktons were recorded in summer months and lowest in rainy season.

Keywords: physico-chemical, zooplankton, rotifera, cladocera, copepoda, mahapoli village.

I. Introduction

Zooplanktons are the smallest organisms present in almost all the water body. Zooplankton acts as main sources of food for many fishes and plays an important role in early detection and monitoring the pollution of water. According to Dodson (1992) zooplankton communities respond to a wide variety of disturbances including nutrient loading. Zooplankton is being influenced strongly by all the physical and chemical processes and often used as models for ecological paradigms. Zooplankton communities are highly sensitive to environmental variations and responds quickly to environmental change because most species have short generation times. In an aquatic ecosystem zooplankton are the important component. They provide the main food item of fishes and can be used as indicators of the tropic status of water body said byVerma et al.,(1987). They are the primary consumers. The zooplankton feed upon the phytoplankton which in turn forms a suitable food for fish and other aquatic animals. They also play a key role in the aquatic food chain (Sharma, 1998). The present study deals with the impact of various physico-chemical factors on the abundance of Zooplankton in MahapoliLake.

II. Material and Methods

a) Study area

The present study was undertaken in the Mahapoli village. Mahapoli is a village panchayat located in the Thane district of Maharashtra state, India. The district is situated between 18° 42' and 20°20' north latitudes and 72°45' and 73°48'east longitudes. The latitude 19.4010673 and longitude 73.0847979 are the geo-coordinate of the Mahapoli. It is located around 56.40kmaway from Mumbai.

b) Sample collection and analysis

The present investigation was conducted for the period of one year from February-2016 to January-2017. The samples were collected in morning between 7 to 9 am. The water samples were collected from 4 different points of the lake. Water samples were collected by using one liter wide mouth plastic container at each sampling station. Water quality parameters were analyzed as per methods of APHA (2005), Trivedy and Goel(1984). DO was fixed at sampling stations itself and further analysis was done in the laboratory. For the quantitative and qualitative estimation of plankton, 50 liters of water samples were filtered by using the 125µ mesh size plankton net and preserved in 4% formalin. Literature was used for taxonomic position and identification of the plankton (Tonapi, 1980; APHA 2005).

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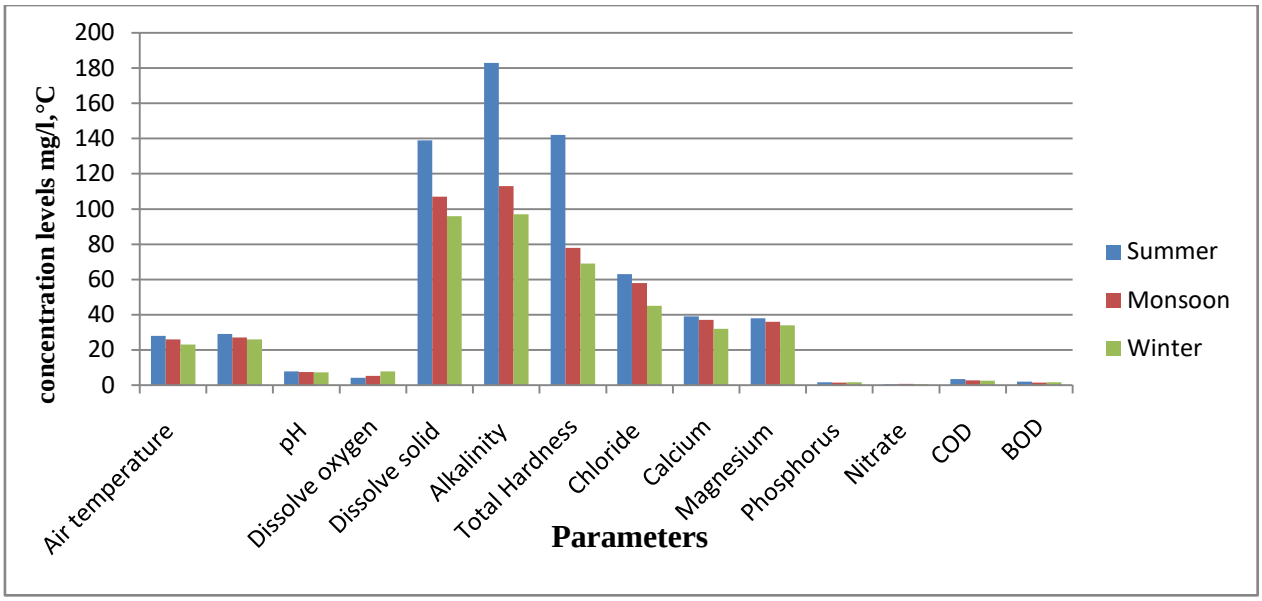

Figure 1: Seasonal average value variation in physico-chemical parameters of Mahapoli lake during February-2016 to January -2017

III. Results and Discussion

In the present investigation, seasonal variation in the physico-chemical parameters of Mahapoli Lake has been illustrated in Figure 1. Water temperature, a regular factor for various physico-chemical as well as biological activities in ecosystems, is found to fluctuate markedly with the variations in air temperature was investigated by Sharma and Kumar (2002). It was maximum during summer comparatively less during monsoon and minimum during winter. Same results as observed in the present study also found by Kannan et al., (1980). Recorded PH of water confirms the alkaline nature of the lake. The parameters like Alkalinity, Total Hardness, minerals and nutrients like phosphates and nitrates were recorded maximum in summer and minimum in monsoon season (Figure 1). According toEdmondson, (1965); Baker (1979)in monsoon the factors like water temperature, DO and Turbidity play an important role in controlling the diversity and density of Cladocera.In the present investigation zooplankton belonging to Rotifera, Copepods and Cladocera groups were identified in the study period of one year. The members belonging to Rotifera are *Filliniasp, Gastropussp, Keratellasp*, and *Brachinus sp*. The Copepod is represented by three members which are *Microcyclopsp, Mesocyclopsp*, and *Nauplius* larvae. The Cladocera members are *Moinasp, Daphnia sp*, and *Bosmina sp*. Qualitative and quantitative assessment of zooplankton was done by zooplankton density.

Table 1: Of Zooplankton Species recorded in MahapoliLake during 2016-2017

Rotifera	Copepoda	Cladocera
Filliniasp	Microcyclopsp	Moinasp
Gastropussp	Mesocyclopsp	Daphnia sp
Keratellasp	Nauplius larvae	Bosminasp
Brachinussp		

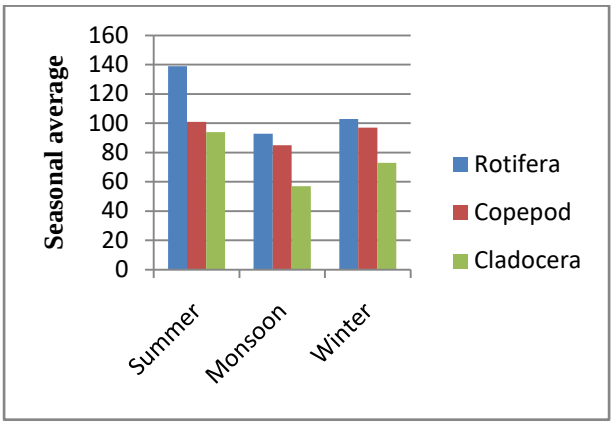

Figure 2: Seasonal Average value variations in ZooplanktonAbundance in Mahapoli Lake during 2016-2017

The diversity and population dynamics of zooplankton is under the control of number of factors such as physico-chemical environmental, tropical status, pollution influence and all types of interaction among biotic communities. A number of studies indicate that temperature, dissolved oxygen, and organic matter have major influence on the zooplankton community.

As stated above the zooplankton of the lake at four sampling station consisted of Rotifers, Copepods,

Cladocerans and some of the larval forms. Rotifers and Copepods mostly dominated the zooplankton population at all the stations during the study period. Theminimum population density of zooplankton was noticed in monsoon whereas maximum population density observed in pre monsoon and post monsoon. George (1961) and many other workers have stated that temperature is the important factor influencing the growth of zooplankton.

Among zooplankton Rotifers comprises the integral part in the aquatic food chain. They are the prominent group among zooplankton of a water body irrespective of its trophic status. This may be due to the less specialized feeding, parthenogenetic reproduction and high fecundity (Sampaio et al, 2002). Maximum density of Rotifers could be recognized with the favorable temperature and availability of abundant food in the form of bacteria and suspended detritus. The lower density of Rotifers as noted in August i.e. during monsoon may be due increase in water level. Alkalinityincreases zooplankton population in the present study zooplankton shows positive correlation with alkalinity. Similar observations were made by Rajshekhar et al., (2010) while studying seasonal variation of zooplankton.

In the present investigation the Copepods were next in dominance to Rotifers. Das et al., (1996) stated that Copepods are high in density in stable environmental conditions and they disappear as pollution level increased. The seasonal variation of Copepods was studied in Indian water bodies by Mathew (1985). In the present study maximum density of Copepods was observed in pre monsoon while minimum was noted in monsoon period. The Cladocera by their abundance and diversity, form the important group in the zooplankton community. Pennak (1958) stated that group Cladocera is well established to form the food of both young and adult fishes. Maximum density was reported in pre monsoon which may be due to availability of food and competition with other species. Seasonal variation of Cladocerans population in Indian reservoirs and lakes has been reported by Rajshekhar et al (2010). Overall Zooplankton population fauna of the lake was not much more diversified indicating the MahapoliLake as nutrient rich water body and good for aquaculture.

IV. Acknowledgement

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The Expansion of Production, Marketing and Consumption of Chat in Ethiopia

By Tesfa Binalfew
Melkassa Agricultural Research Center

Abstract- Chat (Catha edulis) is a plant of uncertain and very debatable status grown in Ethiopia. The chewing of chat leaves has a deep-rooted religious and socio-cultural tradition. It is considered a cash crop and source of economic value to the societies and nations involved. However, there have been reports of negative economic effects on the individuals engaging in the habit of chat chewing. The paper discusses the increasing importance of chat as a major cash crop in the Ethiopian and the controversies that its production and marketing generates. It also presents and discusses the results of the CSA and Revenue data through summarizing. The results of the review show the opportunities and challenges related to chat production and export to Ethiopia's neighboring countries in the process of internationalization. The strategic and policy implications of the results are also addressed. Chat export earnings about 10% share with annual growth of 17.4%.

Keywords: *chat, economy, dilemma, constraints.*

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I. Introduction

Chat belonging to family Celastraceous is considered an evergreen plant, cultivated for the production of leaves having sympathomimetic actions which are used commonly for gradual chewing. This plant is called by different names in different countries: 'chat' in Ethiopia, 'qat' in Yemen, 'mirra' in Kenya and 'qaad' or 'jaad' in Somalia. In Ethiopia, this is grown extensively in the middle altitudes between 1500 and 2100 meters above sea level (masl), and performs better on well-drained soil under diverse climatic conditions. It can tolerate drought conditions for several months. The crop can be harvested throughout the year, thereby becoming a source of continuous income for the producers. The economically important parts of the plant are its young leaves and tender twigs, which are chewed for their stimulating effect. Chat production and consumption occupy a major area in eastern Africa, South-west Arabia, and Madagascar (Pantelis et al. 1989).

Ethiopia is the world's largest producer of chat which has become the fastest growing export commodity. The history of domestication and introduction of this crop in Ethiopia is not known. According to the folklore, it was first introduced in Harar from where it spread to rest of the country (Getahun and Krikorian 1973). About a third of the production is exported to neighboring countries like Djibouti and Somalia. However, it is largely produced, marketed and consumed within the country. The bulk of the chat produced in Hararghe is of good quality and is in great demand in both domestic as well as in export markets. In 1998–99, the crop accounted for 13.4% of Ethiopia's export earnings and was the country's second largest export items that year (CSA 2000). Consumption of chat leaves is common in Middle-East Asian countries like Yemen, Saudi Arabia and East African countries like, Kenya, Somalia, Djibouti, Uganda and Tanzania.

With globalization of chat consumption, the stimulant has found new markets, both within the region of production and internationally. In response to increased demand, more and more farmers in Ethiopia are giving up other crops and concentrate upon chat. Chat is one of the major sources of export earnings of Ethiopia. It is exported to various parts of the world including Djibouti, UK (London), Somalia, and a number of Arab countries. Since the formal export to Aden in 1942 markets were developed (when exports totaling 1,485.8 metric tons valued over Birr 6.4 million were recorded), exports have increased dramatically. In 1999/2000 Birr 0.464 billion worth of chat was exported to different countries and ranked second replacing hides and skins in export revenue (The Reporter, 2000). The above figure, does not, however include the huge volume of chat smuggled to different countries.

The government has a policy of non-engagement with questions of chat production, marketing and consumption (Feyisa and Aune, 2003). Where economies have been devastated by the collapse in livestock and coffee markets, this perhaps is understandable. However, the questions associated with chat extend beyond the borders of Ethiopia into the globalized economy. Chat is being produced and traded not only within the Horn of Africa but is also exported to Europe and North America including to the US, where chat has been classified as an illicit narcotic. From neighboring Somalia to distant Afghanistan and Colombia, the global community has become increasingly concerned about how humanitarian crises and conflict can lead to sharp increases in narcotic activities, with related security implications for local and international community's (Lautze et.al, 2003).

Though officially discouraged, chat stands among the most important cash crops in Ethiopia, with strong markets domestically as well as in neighboring Somalia, Djibouti, Yemen and the Gulf State. As a cash

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crop commonly grown in food insecure parts of the country, the need to understand better the cultivation, botanical characteristics and economics of the plant is very important. On the other side it is better to understand the negative side of the plant and precede its production in such a way that compatible with other horticultural crops.

Therefore, the objective of this paper is to appraisal the current production status of chat in comparison with other horticultural crops in Ethiopia.

II. What is Chat?

Much of the lore of chat has been passed on orally from generation to generation, leaving inadequate written records largely due to lack of interest in the crop by institutions, policy makers and researchers. Hence, the history of its importance as a crop is neither clear nor certain.

Some oral traditions claim that chat originated from Yemen, however the literature indicates that chat originated from Ethiopia, specifically in Hararghe with a gradual expansion to different parts of Ethiopia, Yemen and other parts of the world (Dechassa, 2001).

a) The Chat Plant

Chat is an evergreen perennial shrub plant. The plant is known with different vernacular names: Khat in English and in Arabic, Jimaa in Oromo and chat in Amharic languages. Chat usually grows up to 7 meters but occasionally reaches as high as 15 to 25 meters. Leaves are simple, elliptic, and oblong and are glossy green above but lighter below, leathery and stiff tapering to both ends. The buds and leaves contain an alkaloid and are chewed in a fresh or dried condition as a stimulant. Flowers are small and white. The fruit is smooth and narrow splitting to release narrowly winged reddish seeds when matured. The stem is straight and slender; the bark has different colors depending on the variety and age of the stem and branches. The young branches are smooth and green to pinkish but grey and sometimes rougher and darker on older branches and stems. The root system can grow as deep and as long as 3-5m (Raman, 1983).

b) Uses

In Ethiopia chat is an important and potentially lucrative cash crop. The employment opportunity created through the cultivation of chat is very high in that large numbers of people are involved in growing, harvesting, sorting, packing, transporting, loading and unloading the commodity. Chat is profitable to the huge number of people involved in its production and marketing, including farmers, distributors and merchants. The taxes imposed on chat are also an important source of revenue to governments.

The wood of the plant is commonly used for fuel and due to its resistance to termite is used in the construction of houses and fencing. It is also used for making rafters, handles of farm tools (hammers and chisels) and handles of household articles such as pots and pans, rolling pins, and to make forks, combs, spoons and for rulers.

Students and a number of staff in higher education institutions and high schools are using chat to "increase" their concentration levels and attention span.

Some of the farmers' responses that chat give them energy and strength to accomplish a great deal of agricultural and other hard work, which they say, would otherwise be impossible. This is common in Hararghe where hand cultivation is extensively used in seedbed preparation and cultivation; chat chewing enables them to accomplish the work without fatigue. They also cited the additional "advantage" of a reduced appetite in food shortage periods. The crop also has prestige value for people who grow large quantities (Tesfaye, 2003).

Chat has considerable social value. It is served to welcome and entertain guests, in mourning, weddings and circumcision ceremonies and collective labour works. Chat chewing has its own associated ceremonies like smoking of incense, cigarettes and use of drinks (soft drinks, tea and milk).

Chat chewing has a deep-rooted religious and socio-cultural tradition. It is especially highly regarded as a social event, where it is used for recreation and relaxation. For the participants in chat sessions, it is also a way of redefining their identity and reinforcing self-esteem both at home and as migrants in an alien society. At the same time, chat sessions are an important source of news from home and an opportunity to exchange information on the society in which those involved in chat chewing find themselves.

Chat cultivation plays key role in scheming soil erosion, which is a major threat in the Ethiopia due to the undulated topography and intensive deforestation for farmland expansion and hence chat culture is considered the best agro-forestry system practiced by farmers. For example, had it not been for the cultivation of chat, the erosion of topsoil would have been severe and possibly disastrous in midland areas of East and West Hararghe zones.

c) Demerit of Chat

Chat chewing is addictive and has negative physical, economical and social connotations. Although non-users both in rural and urban areas condemn the practice of chewing, the number of people chewing is increasing particularly among the youth. In urban areas, chewing chat is a common leisure activity which, combined with the consumption of it, followed by alcohol is having an adverse effect on family life.

Farmers in eastern Ethiopia often start chewing chat right after breakfast and work for about 3 hours without any feeling of fatigue. After lunch, they resume chewing and work through the remaining afternoon with

intermittent chewing. It is evident that chat chewing competes for active working time in that the actual working hours do not exceed 6-8 hours a day. Furthermore, in areas where chat chewing is common, such as in Afar, Somali regions and Hararghe zones of Oromia region, punctuality of business appointments is a frequent problem, as the time after lunch is usually spent in chewing chat.

III. Distribution of Chat in Ethiopia

The distribution of chat in tropical Africa extends from north Arabia to South Africa. In Africa it is well established in Ethiopia, Eritrea, Somalia, Kenya, Tanzania, Uganda, Burundi, Rwanda, Democratic Republic of Congo, Zambia, Zimbabwe and South Africa, despite efforts of the respective governments to discourage its cultivation. In East Africa it grows in the range of 1500-2500 meters above sea level (masl). Outside Africa it is planted in the Arabian Peninsula, Yemen, Afghanistan, India and Sri Lanka for consumption and in the USA, UK and France for experimental purposes (Dechassa, 2001).

The major production area of chat in Ethiopia is the Hararghe highlands located in eastern Ethiopia. It has however been observed chat production has also been expanding in other regions of the country.

Farmers have developed appropriate spacing, defoliation time, other cultural practices, cultivar selection and disease control methods including use of chemicals such as DDT. All of these were popularized and done independently without any government involvement or assistance from farmers' associations.

Despite silent support and objection against the crop by development institutions, chat is cultivated and expanding in different parts of Ethiopia. At present chat is being grown for sale not only in its traditional areas in Hararghe but in Jimma, Shashemene, Sidama, Kembata, Gurage, and even as far as Debre Libanos, Gojam, Wollo and Tigray.

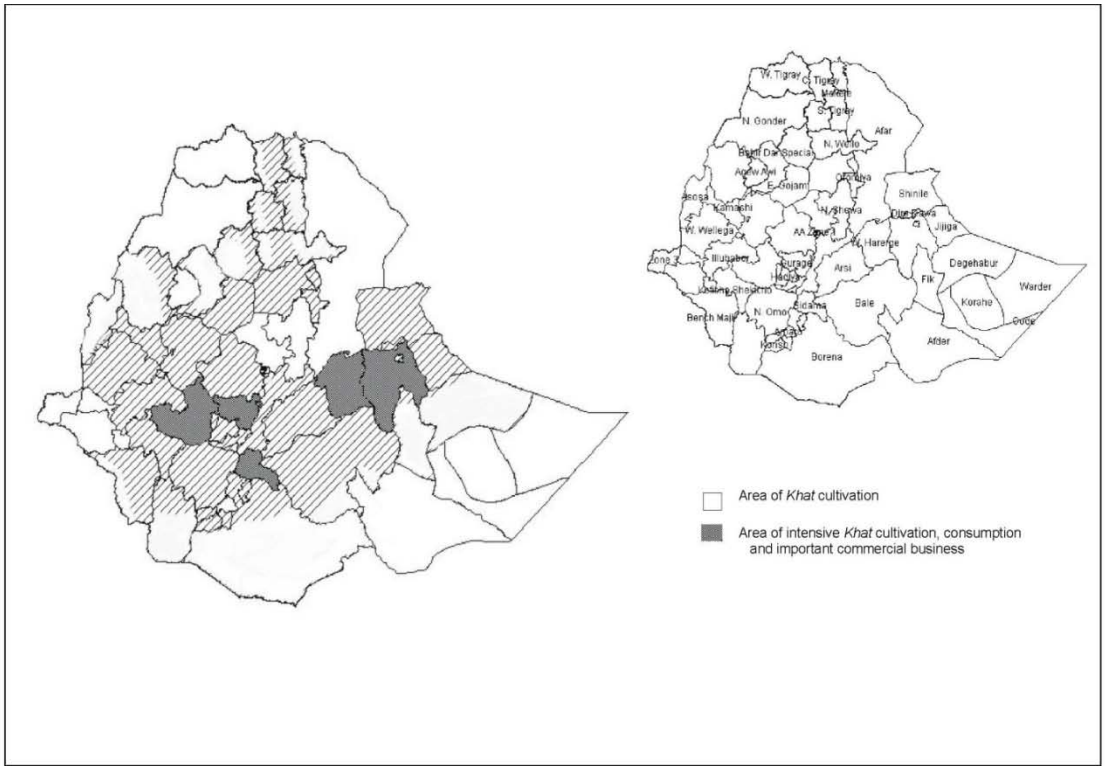
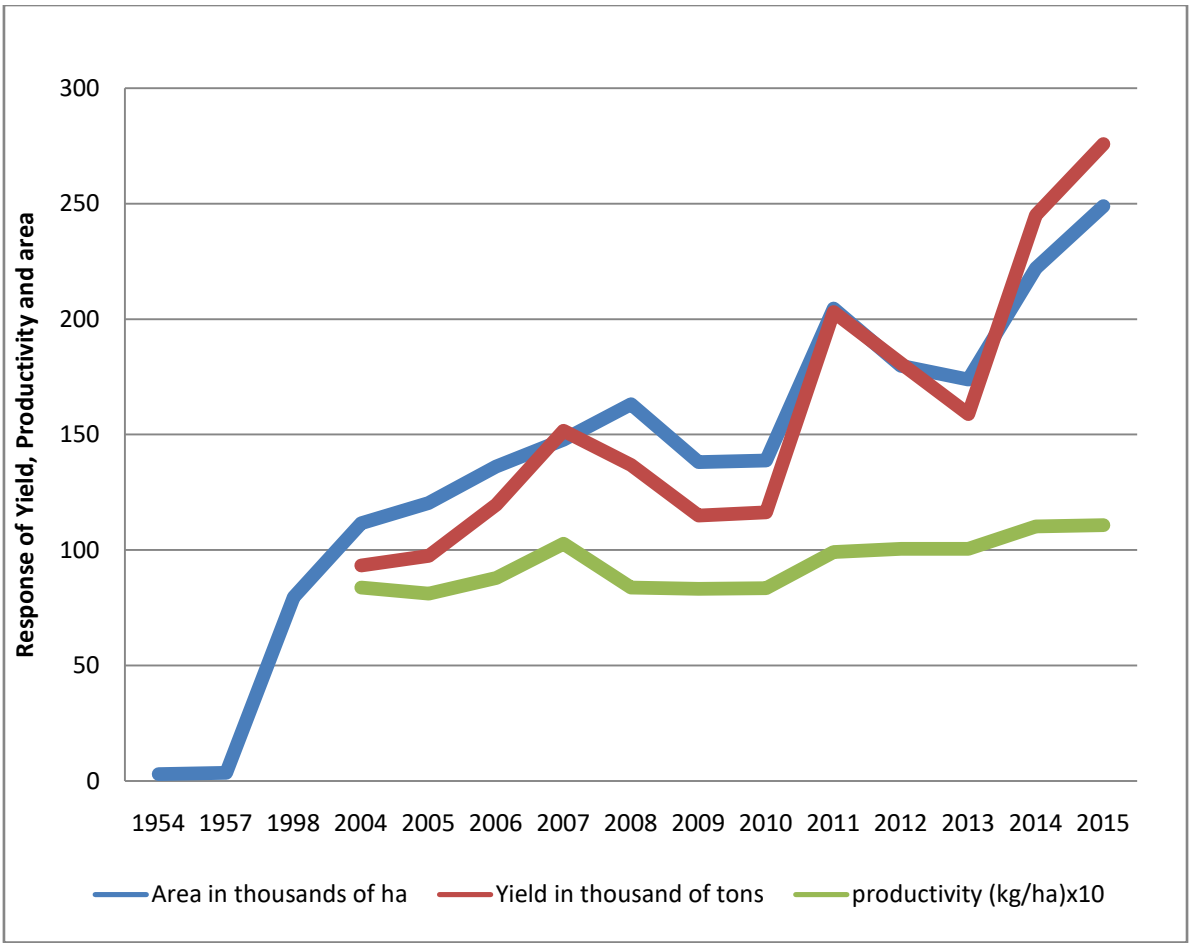


Figure 1: Map showing distribution (rough) of chat in Ethiopia (adopted from Dechassa 2001)

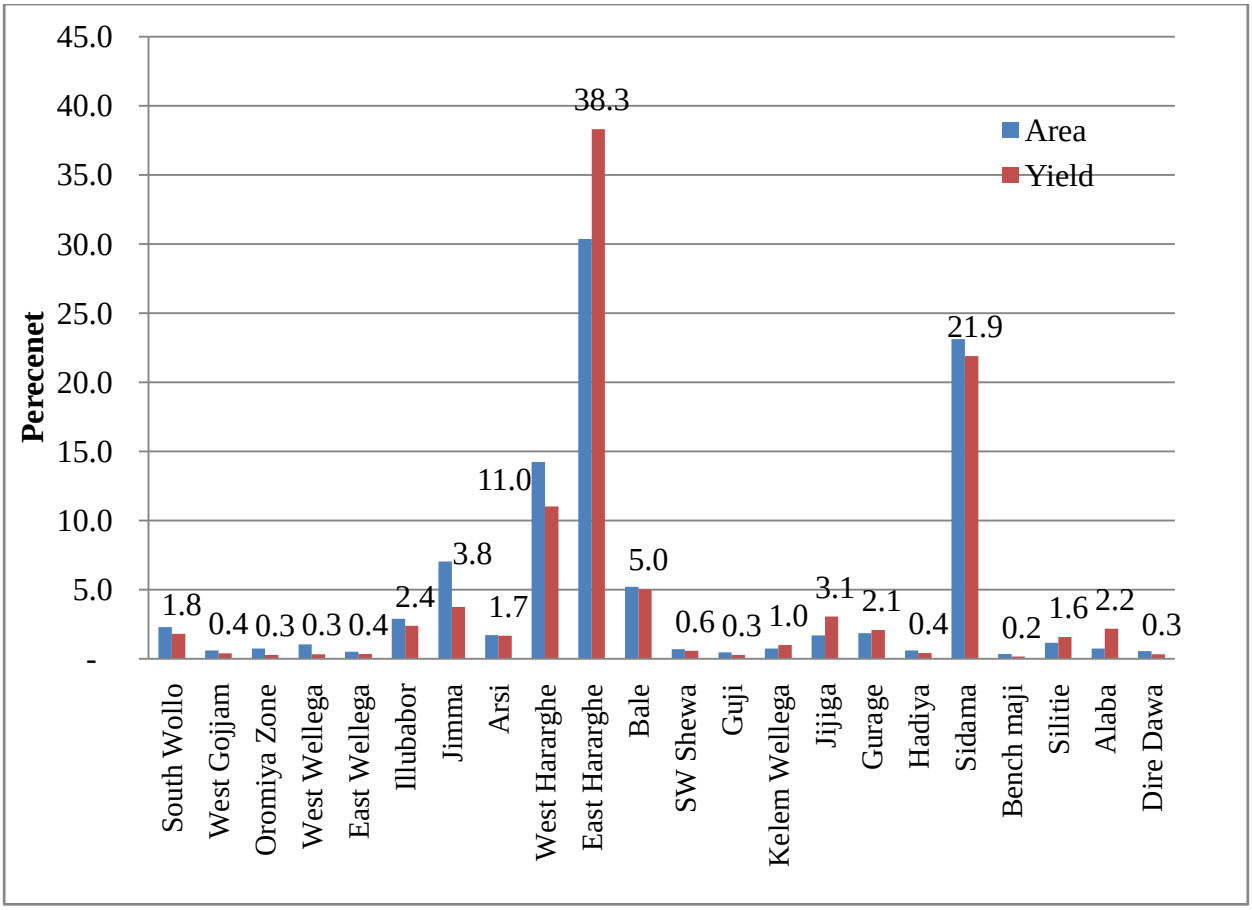
The expansion of chat plant in Ethiopia has been increasing radically. If we investigated the total area of chat plant some thirty years back was 3000ha, 3500ha and 6997ha in 1954, 1957 and 1961 respectively (Amare and Krikorian ,1973). According to CSA the total area of land under chat cultivation in the year 1998 was estimated at 78,570 ha in 2008 increased to 163,227ha and then 204,648 ha in 2011 and in 2015 it reached 248,964 ha. Correspondingly the yield gained has increased. However, there is little improvement in productivity of the crop through time (fig 1).



Source: Calculated form CSA data, Amare and Krikorian, 1973

Figure 2: Chat Production Trend in Ethiopia: 1954-2015

Oromia, mainly East and West Hararghe zones, is the most important centre of chat production. The two zones alone contribute half of the total product in Ethiopia. Hararghe is also considered as the most important producer of quality chat in the world.



Source: Calculated form CSA 2015

Figure 3: Share of Major Chat Producing Zones in Ethiopia, CSA-2015

IV. Chat Expansion and Policy Issues

The increasing use and consumption of chat has become a major concern to many countries especially to Djibouti, Somalia and Ethiopia who have found it necessary to prohibit its cultivation at different times. Nevertheless, past efforts to ban the crop in these countries and to replace it with other crops in Ethiopia and uprooting the crop after paying compensation in Somalia did not last long. The failure was largely due to the exclusion of the farmers from the decision-making process and more importantly, due to an absence of any viable substitute that could fully compensate the merits (traditional, economic, social, environmental benefits) obtained from the cultivation of chat. Chat sparked a commission of inquiry, under the supports of the League of Nations and the UN Commission on Narcotics and Drugs (UNCND) found the issue of chat consumption and its effects quite controversial often postponing several meetings as the plant's narcotic effect was insufficiently understood due to lack of viable clinical research information (Dechassa, 2001).

The legality of chat, however, varies from country to country. The economic effect of chat on individuals and societies that engage in chat chewing furthermore seems uncertain; these uncertainties make the habit of chat chewing controversial and ambiguous. The increasing use of chat and the negative attention have led to the present uncertain status of this once indigenous practice.

Lautze *et. al*. (2003) argued that the expansion of chat cultivation to extraordinary levels poses a dilemma for food security. Some suggest that the cultivation of chat will grow unabated at the expense of other crops in the coming years, thereby reducing both household and national production of staple foods. Staple crop losses due to increasing chat production will look on the national balance sheet as though there has been a straightforward loss in food security due to an apparent decline in food availability rather than taking into consideration positive income effects associated with chat production.

Tefera *et.,al* (2003) explained that the most important lesson that policy makers can learn from the chat case is that the provision of research and extension service is on its own insufficient to get smallholder agriculture 'moving'. Delivering research and extension service will only bring the urgently needed quantum leap in the increase in production and productivity to feed mouths growing at unprecedented rate in Ethiopia and

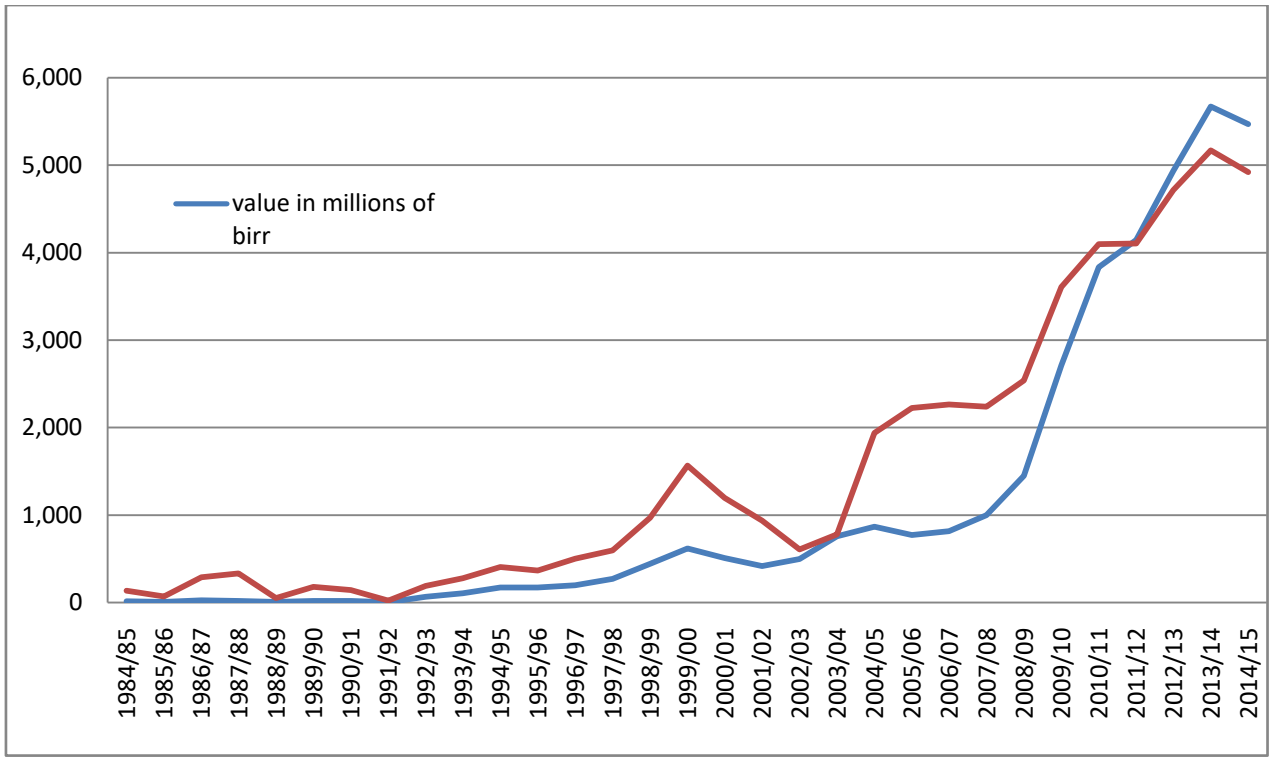
elsewhere in the Sub-Saharan Africa if and only if it is combined with creation of market incentives.

Without an international agreement on chat, akin to the 1961 Single Convention on Narcotic Drugs which specifically prohibits the production, distribution and possession of a list of substances – cannabis, coca and cocaine, opium and derivatives – the status of chat is determined by national legislation. With a number of core countries engaged in large scale production, and emerging markets in the Diaspora, the export trade is bound to continue for some years to come. More dramatic still is the expansion of chat production into new areas along the shifting chat frontier (Klein, 2008).

Expansion of chat production in the Ethiopia has mainly been driven by market incentives. According to Tesfaye *et. al.* (2003) shifting the scarce land and other resources to chat has significantly increased rural income, positively contributed to food and nutrition security of the households, and soil conservation. It has also become an additional source of the foreign exchange earnings for the country. A major shift to chat production and using proceeds from chat sales to finance the adoption of improved technology and fill grain deficit has prevented or postponed the total collapse of livelihoods in this part of the world.

The policy dilemma for the government is vested in two alternative policy scenarios. One option is to accept chat production as a major contributor to livelihoods of the households and to use part of the tax revenue it generates to support the enterprise. The second option is to continue considering chat as a 'drug' and perhaps enforce a shift to other cash crops as the previous government attempted in vain. The first option is considering legal chat production but in such a way that with integrating other field crops. Few non-farm job opportunities will exist in the absence of the chat sector since chat processing, packaging, transporting and distributing is currently the single most important source of alternative employment and income. The policy makers should also be reminded that serious negative health effects of smoking are scientifically well established yet the production and marketing of cigarettes has continued to protect income and employment. Indeed health impact of chat is not yet well established and likely to be tolerable. However, discarding nutritionally and economically important vegetables, fruits and coffee and replacing with chat has immediate and long-term effects on the society.

So far governments in Yemen, Ethiopia, and Kenya have resisted calls for tight controls, even though the issue of chat remains contested. All these countries experienced some form of control during the colonial era, French Djibouti (1956-57), British Somaliland (1921-57), South Yemen (1957-58) and Kenya (1945 – 1956), and many policy makers are aware of health problems and the drop in productivity. Yet, the substance is so culturally embedded and the economic benefits so important that the idea of a ban is unthinkable. For Ethiopia, chat remains a key export.



Source: ECRA, 2016: Klein, 2008

Figure 5: Value and volume of chat exported of Ethiopia over years

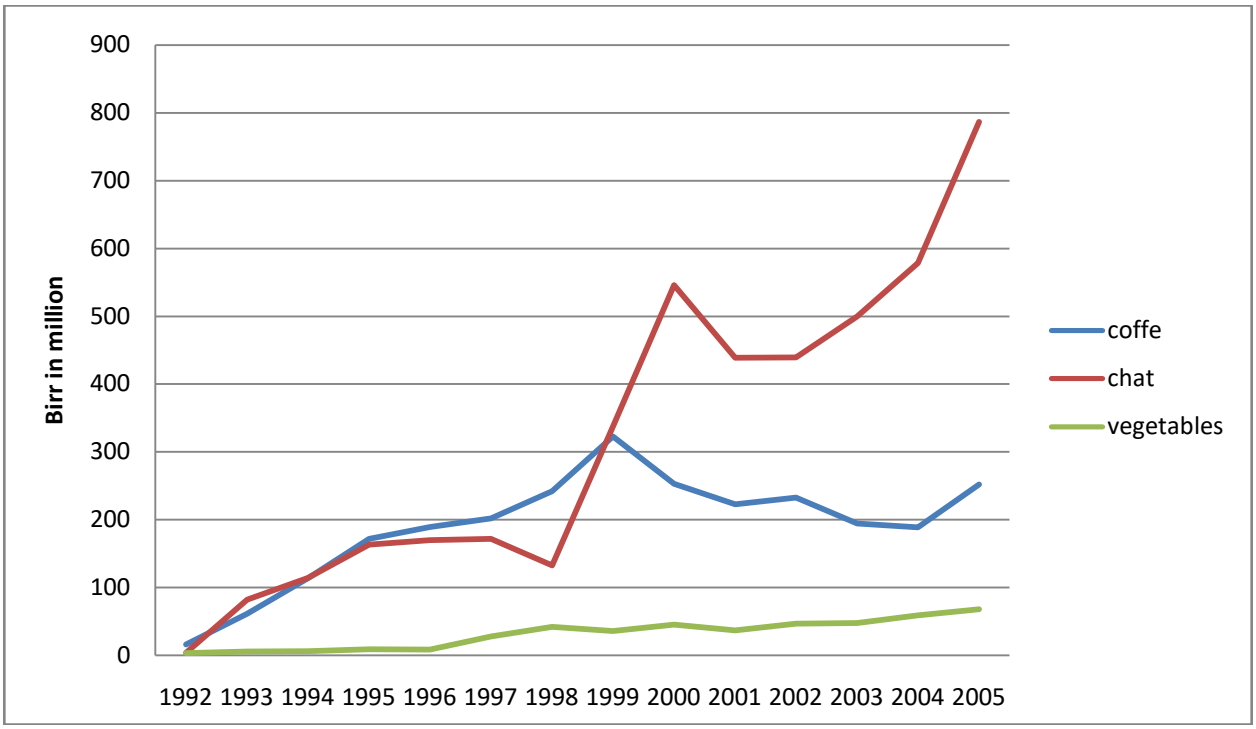
In the meantime chat production is moving swiftly into new parts of Africa, providing consumers with a low cost form of entertainment in rapidly urbanizing continent and farmers with a new cash crop. In each country where chat use takes root discussion over the legality take place. Where governments follow the advice of international agencies to control the substance, like in Rwanda or Tanzania a lively contraband trade develops. Countries with ambivalent control regimes, like Uganda, engage in long public discussion while production increases and consumption picks up *(Klein 2008*).

V. Factors Contributing for the Expansion of Chat

There are a number of factors that are contributing to the expansion of chat production in the Ethiopia. The first, perhaps the most important, is growing domestic and export markets for chat and improved access to these markets an improved transport network. The export market is substantial and expanding. This includes countries such as Djibouti, Somalia and some Arab countries such as Yemen. Chat is also exported to Europe, but is banned in Canada and the United States of America. The Hararghe highlands' location and its superior transport network have played an important role in the expansion of chat since the product has to reach its final destination fresh and therefore fast transport is needed. In the domestic market, it is quite evident that chat chewing has become a recreation activity and now also forms part of the culture of the urban youth (Tesfaye *et. al*., 2003).

Farmers in a number of areas in Ethiopia grow chat, which is used as a stimulant, and which provides considerably greater incomes than can't be achieved with the cultivation of other cash crops, including coffee. Less labour and fewer other inputs are required for the cultivation of chat than for other cash crops.

Chat has not only been of significant benefit to the Ethiopian economy, it constitutes in terms of both bulk and value one of the most important items of trade between Ethiopia and neighboring countries Somali and Djibouti. This is particularly significant in the light of the continuing lack of horizontal linkages between African economies (Klein, 2008).



Source:

Figure 6: Export Earnings from Eastern Ethiopia, 1992-2005(in million Birr)

The export price is also rising. While chat enjoys a relatively stable price at the world market, coffee suffers from both fluctuating export volumes and prices. As it is observed in the figure above the export earning of chat is still rising while the value from coffee drop down the earning from fruits and vegetables is remain minimal through time. Producing chat has thus become a viable and important alternative to ensure continued cash income. Chat has additional advantage because it can be harvested at least twice a year under rain fed agriculture while up to five harvests per year is possible under irrigation. This ensures that households have a well distributed flow of income.

Another economic factor for the growing interest in chat production is related to its cost of production relative to other competing enterprises. Labour is the most important cost item in the production of chat. Rapid population growth in the highlands of Ethiopia has provided enough family labour or highly cheap hired labour for labour-intensive production, making chat production feasible. In the second place, chat is hardly affected by any disease except some damage by insects that can easily be controlled by locally developed methods at little or no cost. Chat need for minimum off-farm inputs makes its production compatible with poor farmers' limited access to credit (Tefera *et.al*, 2003).

VI. Chat and Horticultural Crops

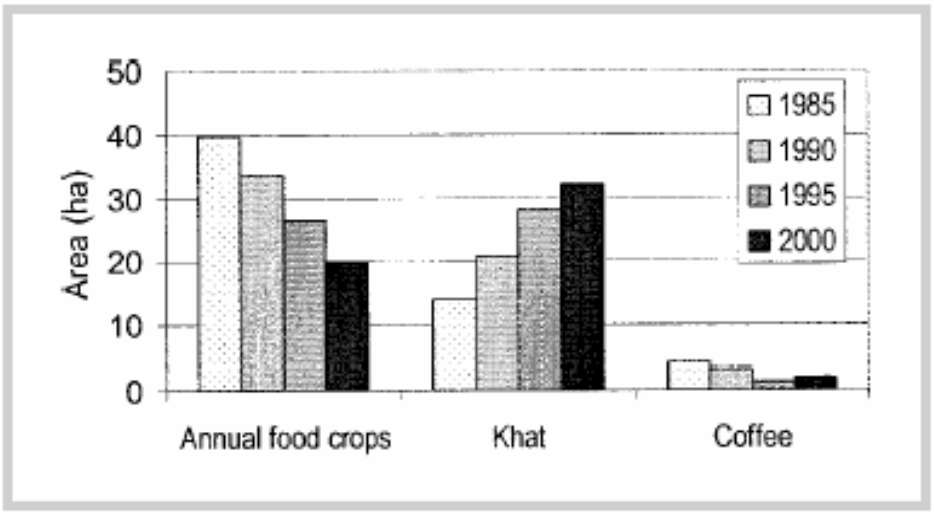
Enriched with diversified agro ecologies, Ethiopia is a country where different types of horticultural crops including fruits, vegetables and herbs are successfully produced under small-scale farming. Production of horticultural crops in Ethiopia has long been meant for home consumption and local markets. With the availability of tropical and sub-tropical climatic conditions in Ethiopia, peoples intended to involve in this sector could produce variety of fruits, vegetables and herbs that the current world is demanding. So long as growers demonstrated safety of products and consistent enough in the supply of produces in the desired amount and time, they could successfully satisfy local demand and penetrate in to the international markets (Hailab et al., 2011). However, the ever increasing chat demand and market incentives, forced most Ethiopian farmers to allocate their scarce land resource from fruit and vegetable production to mono-cropping pattern of chat production, such as eastern Hararghe.

In some areas of the Hararghe highlands, in particular the chat-belt of Haramaya, it was found that the area of cropland allocated to chat is as high as 75% of total arable land (Save the Children Fund/UK, 1996). According to the survey (Tefera) area, cropland area allocated to chat ranges from 21% in Kuni (Chiro District) to 54% in Haramaya. It was also observed that the majority of irrigated land is allocated to chat production and in addition, chat enterprise consumes most of the scarce organic manure in farm households. It can be grown rain fed and/or irrigated, though the later covers less than 20% of the total chat production area. The crop could be planted both in home garden and in the field.

The expanding geographic and social distribution of the production and consumption of chat has specific implications for food security. Originally used as a social pastime among predominantly Muslim populations, more women and children are now consuming chat, while its use is now widespread among many Christian and Muslim and rural and urban populations alike(Lautze et. al, 2003).

Guinand (1999.) indicated that chat and coffee are the two major cash crops produced in Hararghe. Whereas chat witnessed a tremendous boom these days, coffee is facing a major drawback due to unstable and decreasing prices at the international stock exchanges. Many farmers opted and are opting to cut down their coffee plantations and to replace them with chat bushes. But chat is not only taking coffee's place, it is also planted in favour of staple crops. Many parts of the Hararghe highlands, East and West Hararghe alike, are beginning to turn into a monoculture landscape with chat being the dominant crop planted and seen everywhere.

According to Feyisa and Aune 2003 study results in Habro District, Western Hararghe as Quoted Chat production in this district is rapidly replacing cereal and coffee production. About 70% of farmers' income in the study area is currently obtained from chat. One important reason for the expansion of chat production is that the chat-maize intercropping system is 2.7 times more profitable per hectare than maize mono-cropping. Chat is also less risky to grow than cereals and coffee because it is less vulnerable to drought. Increased production leads to changes in livestock composition because oxen are far less needed for ploughing in the chat-based system; moreover, availability of crop residues for fodder is reduced when chat expands. Chat growing farmers, therefore, give more emphasis to milk-producing animals such as cows and goats. It was found that chat producers also are consumers of chat and that chat consumption has become widespread in the nearby secondary school. Chat consumption negatively affects peoples' working capacity. Hence, unskilled chat consumers in urban areas are paid 7 birr (US$ 0. 84) per day, whereas non-chat users are paid 10 birr (US$ 1.22).



Source: (Feyisa and Aune, 2003)

Figure 7: Chat Production Supplanting Food Crops and Coffee, Results of a Survey, Habro District, Hararghe

a) Small-Scale Irrigation

Small-scale irrigation can promote rural food security, poverty alleviation and adaptation to climate change. It enables households to generate more income, increase their resilience, and in some cases transform their livelihoods. Small-scale irrigation is a policy priority in Ethiopia for rural poverty alleviation and growth (MOFED, 2006), as well as climate adaptation. Only around 5% of Ethiopia's irrigable land is irrigated (World Bank, 2006), and less than 5% of total renewable water resources are withdrawn annually, so there is considerable scope for expansion.

Irrigating households reported an average 20% increase in annual income since adopting irrigation, and in some cases up to 300%, due to cultivation of higher value crops, intensified production and reduced losses. Nutrition was said to have improved as various fruit and vegetables became locally available. On the other hand production of chat is mainly located close to the road network and on farms with irrigation facilities. Similarly most horticultural crops are produced through irrigation. So this scare resource, small-scale irrigated land, is allocated for fruits, vegetables or chat based on the market incentives. Economic considerations are very important in peasant farmers' resource allocation decisions. The driving forces for production of either fruits and vegetable or chat have probably been increased market opportunities and favorable prices. Thus production of chat substituting fruit and vegetables crops become farmers' alternative to ensure continued cash income. Chat has additional advantage because it can be harvested at least twice a year under rainfed agriculture while up to five harvests per year is possible under irrigation. This ensures that households have a well distributed flow of income (Tefera *et. al*, 2003).

Although fruits and vegetables production and export is at good growth rate with government encouragement, chat production and export is in a much more growth rate than other horticultural crops. Therefore, compromise production of these sectors is important since both of them are produced in a small piece of land with irrigation. For example, small-scale irrigation is encouraged and increased in Nile basin area of north western Ethiopia. The commodities of either chat or fruit /vegetables production is farmers alternative based on market force. In this new area chat production seems boom; there is daily supply chat for all outlets of Bahir Dar including central market Addis Ababa. According to CSA 2010, Amhara region has more than 5 thousand hectare of chat which is much of the production is around Abay basin, Lake Tana area. Chat production is expanding with an alarming rate that famers give priority for production of chat in their piece of irrigated land. This makes to slow down the very important sector fruits and vegetables production and expansion in the area. Similarly, Hararghe was known with its high available quality of fruits (citrus, mango etc.) some 20 years ago but not now, substitute with chat. In west and East Hararghe highland about 60366 ha of land is allocated for chat/chat production but only 17988ha for fruit production (CSA, 2005).

b) Consumption and Nutritional Influence of Chat

Ethiopia has a variety of fruits, leafy vegetables, roots and tubers adaptable to specific locations and altitudes. Horticultural crop production in Ethiopia is scattered throughout the country on patches of land in peasant smallholder farm. The major producers of horticultural crops are small scale farmers, production being mainly rain fed and few under irrigation. Shallot, garlic, potatoes and chilies are mainly produced under rain fed conditions. Tomatoes, carrots, lettuce, beetroot, cabbage, spinach and swisschard are usually restricted to areas where irrigation water is available.

The carbohydrate in vegetables and fruits has low to moderate energy value. Fruit contains protective vitamins and minerals, and dietary fiber but very little protein. They are practically fat-free except for avocado and olive, both of which contain up to 15% of fat. Vegetables generally provide between 10kcal and 50 kcal per 100g; their nutritional advantage is that they offer a high concentration of micronutrients for low contents of calories and fat. Virtually every national or international report on diet and health recommendations calls for an increase in fruit and vegetables consumption to replace high energy foods. Despite an enormous potential and a favorable environmental and Socio-economic advantage, horticulture is relatively under developed. The margin of the current achievements, in terms of area and output is a small development compared to the possible level that can be attained (Semeret, 1992).

These eating habits create very poor consumption preferences for most of fresh fruits and vegetables. The average annual per capita consumption of horticultural crops estimated to be 48 kg for the rural and 37 kg for the urban population (Bekele, 1989). Horticultural crops play a significant role in developing country like Ethiopia, both in income and social spheres for improving income and nutrition status.

Fruit and vegetable consumption is a win-win approach as it gives added-value to the horticultural products and income to the producers. It is an efficient way to address poverty alleviation, take care of the health and well-being of the consumers, and offers new market opportunities for farmers, consumers, and agro-industry. In addition to the FAO-WHO initiative, such an approach is supported by the Global Horticultural Initiative (GlobalHort) and is now considered globally as a good way for reaching the United Nations Millenium Development Goals (MDGs). A very low consumption of Fruits & Vegetables is generally synonymous with under- nutrition and consequently under-weight (Grany, 2009).

With regards to the practice of own production/cultivation of common vegetables and fruits, the study showed a bleak picture in Ethiopia. When the fact that the proportion of households who reported to have cultivated/produced included those who had a single seedling/plant of a vegetable/fruit in their gardens even once over the year is considered, it is obvious that the proportion of households who produced adequate fruits and vegetables in their gardens/homesteads is negligible. Based on World Health Organization (WHO) recommendations suggesting unavailability of dark green leafy vegetables for more than six months in an area as indicative of increased risk to Vitamin A Deficiency-VAD (WHO, 1996), many regions in Ethiopia can be considered as VAD endemic.

According to Tsegaye *et.al* (2009) study regarding cultivation and consumption of vegetables and fruits is extremely sub-optimal in Ethiopia, calling for strengthened efforts to promote production and consumption of fruits and vegetables. The high consumption of root crops-potatoes, sweet potatoes, yams and the root of the false banana called enset (*Ensete ventircosum* L.), which is predominate in the south central part of the country, the eating habits in the big towns and their surroundings which is the mixture of foreign dishes and the high Landers staple food, injera and wat.

VII. Summary and Conclusion

Chat is clearly an essential cash crop in Ethiopia distinguished for its foreign currency earnings. However, it is little understood and given no development and research attention yet. Millions of people both in Ethiopia and other countries are making a living from the crop. Nevertheless, it is mostly observed as a socially undesirable “drug plant”.

Farmers possess considerable knowledge of the crop and appear to be the best experts of chat production than anybody else so far. They also appear to drive a substantial cash income from the sale of the chat despite the absence of technical support and massive.

It is recommended that a better understanding of the economic benefits and demerits of chat be developed through a multidisciplinary approach with the full involvement of chat growers and traders. The findings derived from such an approach should then be considered against an understanding of the negative physical and social effects of chat use/abuse before considering possible strategies to assist chat growing communities through the substitution of alternative crops, such as coffee and fruit/vegetables. Only through a balanced analysis, taking into consideration all factors (economics, social, cultural and environmental), can the cultivation, use and economics of chat are understood in a proper context.

In summary, concerning chat growing the government as well as all stockholders should involve. Reducing the addiction behaviors and mono-cropping; producing with other horticultural crops side by side to earn the income. The government interference is obligatory about the crop expansion status. It is better to have all the necessary research outputs about the crop.

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Spatial Variation in Distribution of Avian Guilds in Response to Plant Species Composition, Habitat Structure and Land use in the Harena Forest of the Bale Mountains National Park, South Eastern Ethiopia

By Anteneh Shimelis
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Summary- An avian bird community in a forest was classified in to guilds apriori with the objective of determining whether species in the community are clustered naturally in response to bottom processes that have significant direct and indirect effects on birds at various levels of ecological organization. The Harena forest had five habitat categories resulted from spatial variations in collective abundance construct of woody plant species. The constraining effect of this division of the forest in habitat quality was the bird community there was found to have 9 guilds classified according to their adaptive traits which resulted in their matching niche occupancy in the forest with segregations as determined apriori. The number of habitat types occupied by the 9 guilds reflected or was equivalent to the number of habitat types determined from the collective abundance construct of woody plant species.

GJSFR-C Classification: *FOR Code: 060899*

Strictly as per the compliance and regulations of :

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I. Introduction

A community of birds usually constitutes several guilds. Species members in the same guild can be considered as functionally equivalent because of high similarities in diet composition and the proportion at which the same food resource is consumed (Poulin et al. 1994, del Rio 2001). It is vital to study guilds in a community of animals to explain its structuring along resource gradient (Terborgh & Robinson 1986, del Rio 200). Various authors studied abundance at the guild level and their focus has been evaluating the explanatory value of food resources (Hutto 1985, Peck 1989, Poulin et al. 1993). The floristic composition, habitat structure and human transformation of habitat affect significantly the availability of food and other resources to birds (Remsen and Robinson 1990, Leso and Kropil2007).Such habitat features in a given landscape together with biotic interactions affect foraging behavior of birds (Leso & Kropil 2007).Birds use these attributes as cues to select habitats in a given environment and such pattern of habitat selection affects significantly the structuring of the community both spatially and temporally (Wiens 1989). For instance vegetation structure is considered as one of the primary forces that influences bird foraging behavior through its effects on food availability and the energetic constraints it incurs in obtaining a given food item (Robinson and Holmes 1982). As result the structuring of birds in a community was significantly influenced by the structure of the vegetation as found in a forest in Ethiopia (Shimelsi et al. 2013) and also in other similar forest the same kind of structural response was found (Shimelis in prep.a,b,c) and plant species richness was also shown to be an important habitat feature to which species richness of forest birds responded to (Gove et al. 2008).

A priori classification of the structuring of a bird community is done in the past but whether that reflects the structuring of the community in nature by being responsive to direct and indirect structuring processes whose ability to do so is determined by the fact that they are not evenly distributed in space and time and also the role of other forces such as competition and predation which by their very nature deplete resources are not studied in detail. Doing so is very important to be able to prove that community structuring is a natural phenomenon determined by resource and consumptive consumer interaction processes. In this paper the birds of the Harena forest in the Bale Mountains National Park were classified a priori in to guilds and whether such

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classification or structure is responsive to natural processes that are relevant to bird communities in a real field scenario was investigated and results are presented. A community of birds is composed of one or more guilds. Each guild constitutes species of similar attributes. From this one can infer that members of two different guilds would have significantly different attributes. This leads to the conclusion that there is significant difference in occupancy spatial samples across an array of guilds and high similarity in species of the same guild. Thus we hypothesized the differentiation in adaptation and niche requirements leads to the natural segregation of species pool of the bird community of the Harena Forest in to guilds. Inherent to this hypothesis is the idea that guilds are significantly different in their occupancy of spatial samples and there is high overlap in the occupancy of spatial samples by species that are members of the same guild that compete for the guild's niche.

II. Methods

a) Study Area

The Bale Mountains National Park ($6^0$30'- 7^o00' N, $39^0$30'- $39^0$55 E) is situated in the south-east highlands of Ethiopia; some 400 km away from Addis Ababa, the capital city of Ethiopia. It encompasses an area of 2200km^2. The area contains a landscape ranging from 1500m asl to 4377m asl. The soils are mainly derived from the basaltic and trachytic parent rocks (Hillman, 1986). Five vegetation zones are known to occur in this National park: the Northern Grassland, the Northern woodlands, Ericaceous forest, the Afro alpine moorland & grassland and the Southern Harena forest. The area experience two rainy seasons; heavy rain and small rain. The heavy rain is from July to October, with the highest peak in the August and the small rain from March to June, with the highest peak in April. Records show that this area experiences temperature extremities during the dry season and more or less the same pattern of temperature during the wet season. The highest temperature is 18.4c^o in February and the lowest is 1.4c^o in January (Hillman, 1986).

b) Bird Census

Birds were counted using the point count technique considered the most suitable census method for forest birds (Gibbons et al. 1996). Counting stations were selected randomly (Greenwood 1996, Sutherland 1996) on a 1: 50,0000 topographic map after the study area was stratified in to the five recognized vegetation zones (Hillman 1986). Sample sites were selected in such a way that there was a minimum distance of 200 m between any two. A total of 10 minutes was spent at each site allowing three minutes for birds to get accustomed to the intrusion of the census team. Counts were conducted visually and by ear with one observer conducting the counts throughout the census. In every habitat type a minimum of two days was spent learning the songs of specialized habitat occupants.

c) Census on Habitat Parameters

At every bird counting point 50 m by 50 m quadrats were established to collect data on variables listed in table 1. The number of individuals of every tree species in each quadrat was counted by a biologist with a knowledge of the botany of the site. Percent coverage of the different components habitat structure were estimated visually within the quadrats (Bullock 1996). The proportion of the vegetation on the ground with sign of grazing was estimated visually in four 2 m by 2 m quadrats nested within the larger quadrat. We counted the number of temporary ramshackle shelters built by shepherds in each counting point. The proportion of the land that was converted for the purposes of cultivation and also for paths and other purposes was also estimated relative to the overall structure of the habitat in a counting point. The number of stamps of trees that were cut by humans was counted in each quadrat to determine the extent of logging.

Table 1: Habitat variables measured at bird counting stations

Vegetation	Environmental	Land use
Tree species abundance	Elevation	% grazed vegetation
% tree canopy	% bare ground	Temporary shelters of shepherds
% bush	% dead organic matter	Percent agriculture
% shrub		Percent foot paths
% herb		Tree cutting

d) Analyses of Habitat Data

Using data on the abundance of woody plant species encountered at bird counting stations, an ordination sample sites was conducted. To determine whether this classification of the forest clusters sample sites in to five vegetation zones results in different clusters of samples discriminant function analysis for differences was conducted to generate habitat clusters distinguished in to five zones. By this I mean sample cells were constrained by five habitat categories which on its own is a classification means and the Discriminant Function Analysis was carried out.

e) A priori guild determination

A 77 species large species pool of birds obviously constitutes several guilds each with interacting species members the co-occurrence of which is constrained naturally by the availability of a limited array of shared resources across micro habitats with in one site. Human transformation of habitat modifies the pattern of such an interaction favoring some species and marginalizing less adept species. Because interspecific interactions are more intense within each guild than amongst guilds I hypothesize that the effects of underlying habitat parameters and human modification of the forest manifests itself at the scale of each guild rather than the whole bird community. Proceeding with this thought I identified guilds with their species membership. Using published data on morphological adaptations related to feeding, general feeding habits, habitat occupancy and familial affiliations I created classification variables by assigning species cells a 0 code if the variable of interest did not apply to a species and a code of 1 if the species in question has such attribute.

f) Determining guild distribution from census data

Once the types of avian guilds were identified, habitat membership of a sample was used as a constraining categorical variable and samples with the observed abundance of each species were used as column variables in Discriminant Function Analysis (DFA) to determine clustering of guilds based on the spatial clumping of the collective abundance construct of each. This helped determine whether the a priori guild classification was reflected on the clustering or structuring of species across samples in accordance with their determined guild membership.

III. Results

Ordination of habitats of the forest on the basis of abundances of woody plants resulted in the classification of the forest in to five vegetation zones which in its actuality was the clustering of census locations covering all variations in vegetation composition (Figure 1).

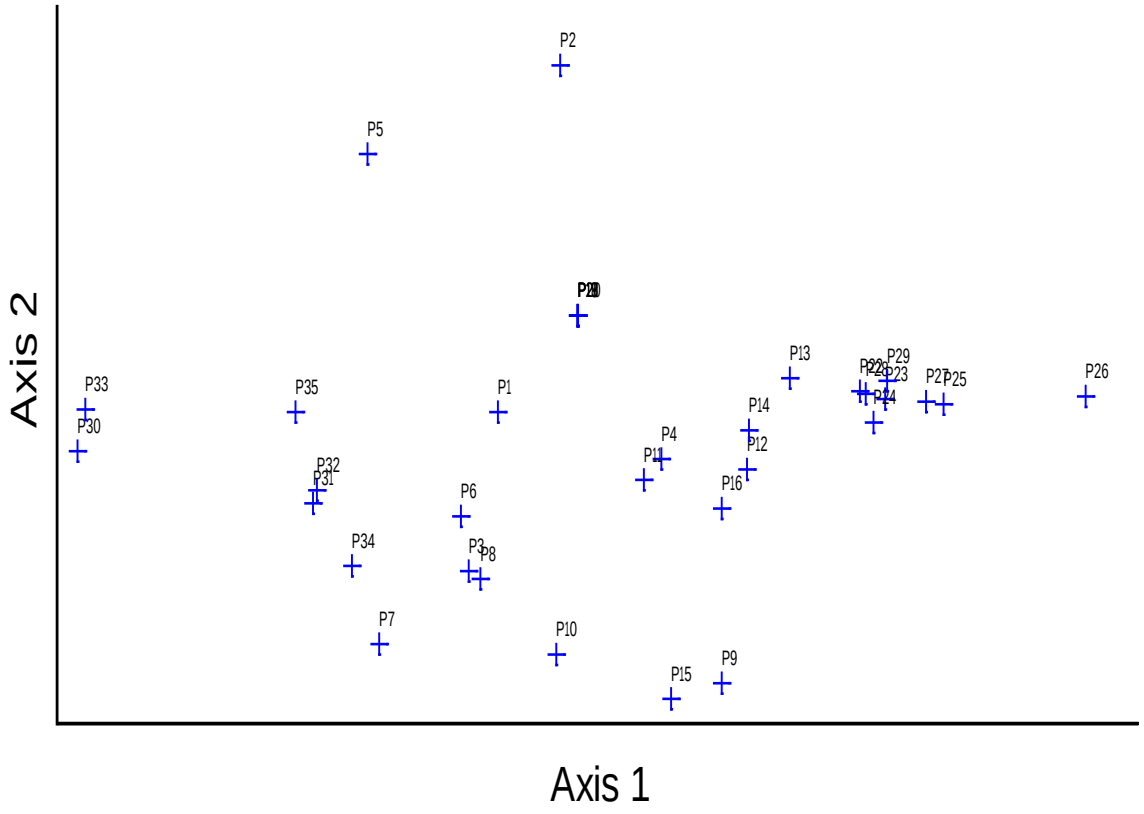

Figure 1: Clusters of bird counting point samples determined using the abundance of woody plant species

Results of the DFA showed that there are five habitat types that were differentiated significantly from each other (Figure 2). The first function significantly separated sample sites (Chi-square = 264.7, $P < 0.001$) by accounting for 57 % of the variation in the floristic data. The second function accounted for 42.3 % of the overall difference amongst groups of samples in woody plant species composition with very high significance (Chi-square = 153, $P < 0.001$).

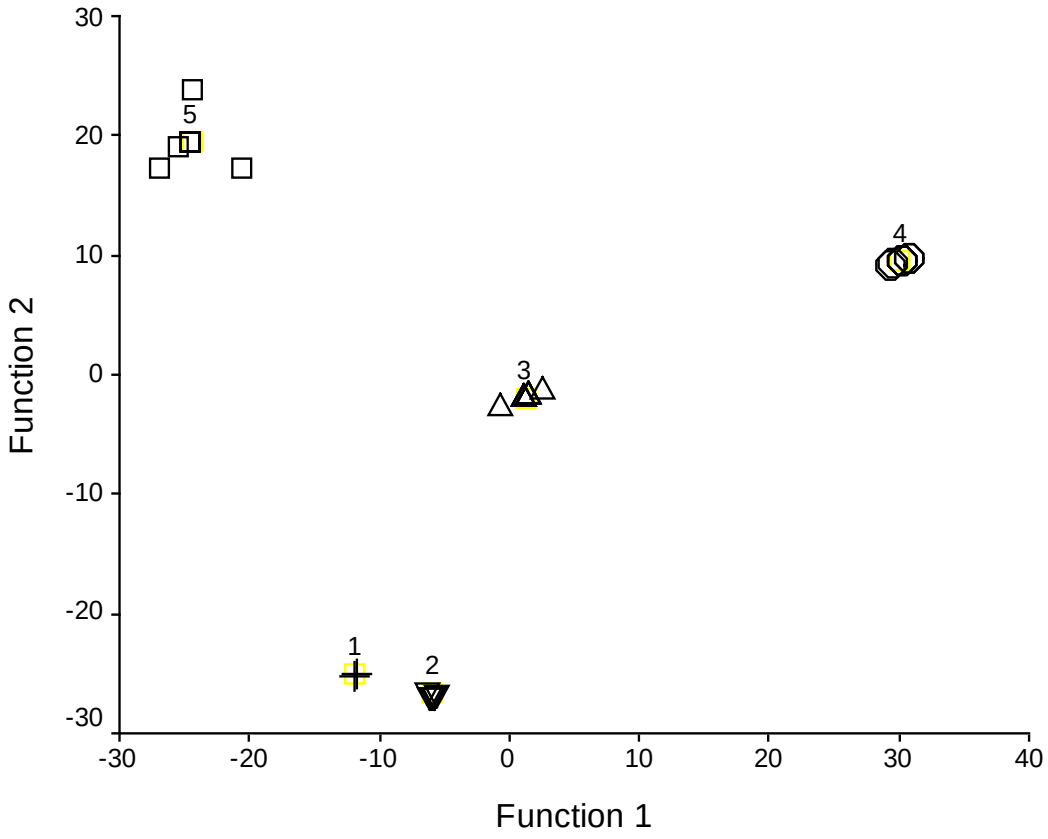

Figure 2: Groups of samples that were significantly different in woody plant species composition

When we evaluated the variation in the mean abundance of all woody plant species across this gradient sample grouping we didn't find significant results. When we considered only the species that are considered to be indicators of the five vegetation zones the variation in mean abundance as was determined by a Generalized Linear Modeling (GLM) was significant (Pillia's Trace = 3.4, F = 3.3, P < 0.001; Wilk's Lambda = 0.003, F = 7.8, P < 0.001). The vertical structural construct of the habitat varied significantly across sample groups as determined by a multivariate analysis of variance (Pillai's Trace = 1.8, F = 3, P < 0.001; Wilk's Lambda = 0.08, F = 3.3, P < 0.001).The overall intensity of human use of the forest did also differ significantly across habitat types (Pillai's Trace = 2.03, F =4.8 , P < 0.001; Wilk's Lambda = 0.02, F = 8.5 , P < 0.001).

Analysis to determine avian guilds and to evaluate of the response of the collective species abundance construct in each to underlying habitat parameters

The resident bird community of the Harena Forest constitutes 77 resident bird species that were recorded as being present in more than three decades. Prior to our surveys the total species list of the forest was 69 (Hillman 1993) and eight more new additions for the forest and the Park resulted from my survey.

A hierarchical cluster analysis was conducted to classify the 77 species large bird community in to guilds a priori. Adendrogram of species similarity was produced (Figure 3).Inferences of guild identification was made at comparable depths of the dendrogram where a minimum of about 65 % of similarity information was accounted for. This identified 9 guilds for the whole resident bird community.

To determine whether species in the bird community were clustered in accordance with the apriori guild membership in a dimension of habitat membership of samples Discriminant Function Analysis was done and results were generated. Guilds differentiated significantly according to the spatial clumping of the collective abundance construct of their species members (Figure 4). The first function accounted for 64.1 % of the variation in the data set high statistical significance (Chi-square = 442.1, P < 0.001). The second function did also separate the guilds according to their respective combined abundances across samples significantly (Chi-square = 368, P < 0.001) by accounting for 22.3 % of the variation in the data set. This result demonstrated guilds responded to habitat parameters in significantly different ways and the high overlap amongst samples in guild composition suggests interspecific interaction is more intense within a guild than amongst them. Since what was presented

in figure 4 can be interpreted as five types of guild occupancies which reflected the available determined five habitat niches depicted in figure 2.

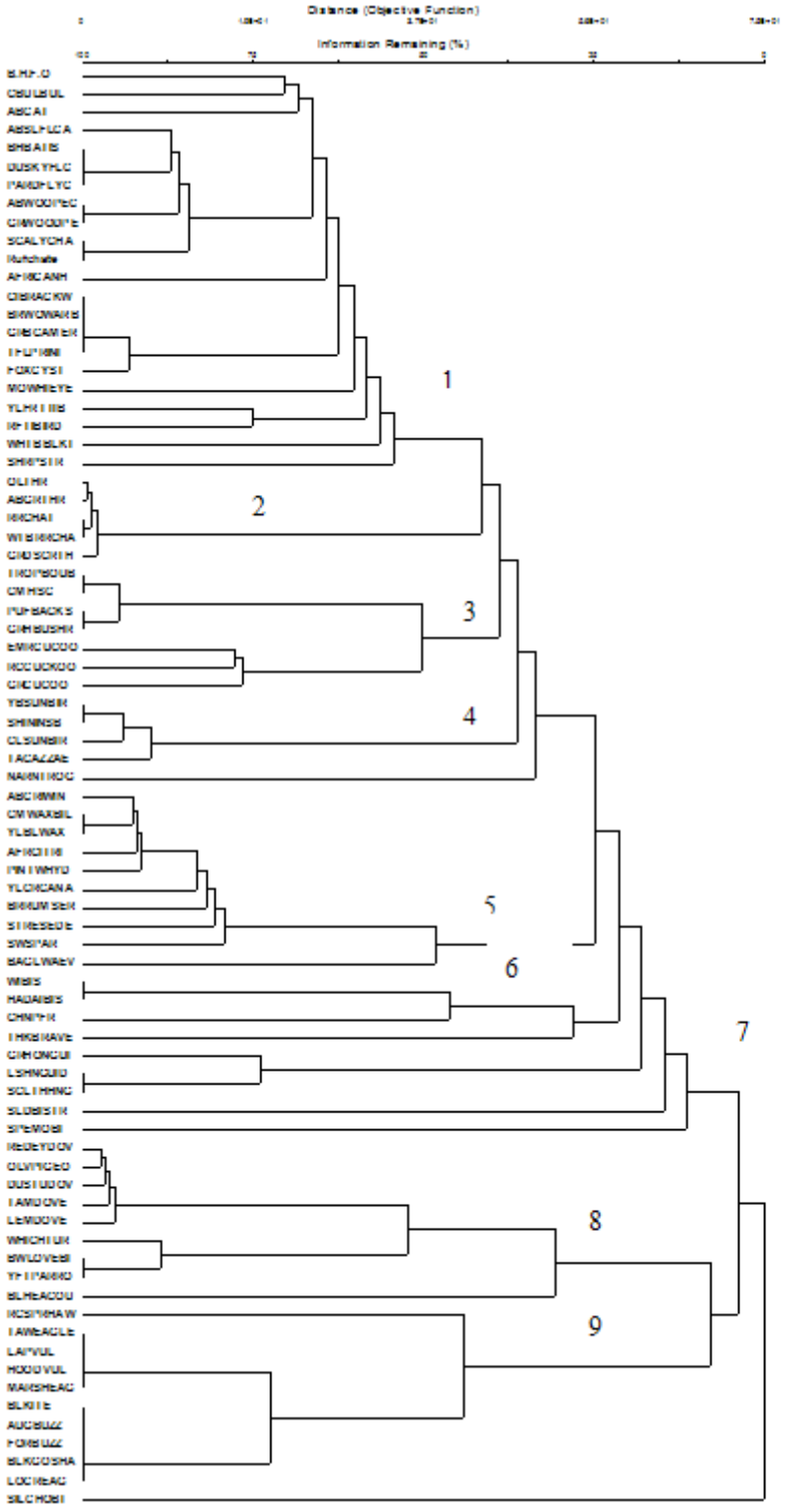

Figure 3: Guild classification according to species similarity in their attributes

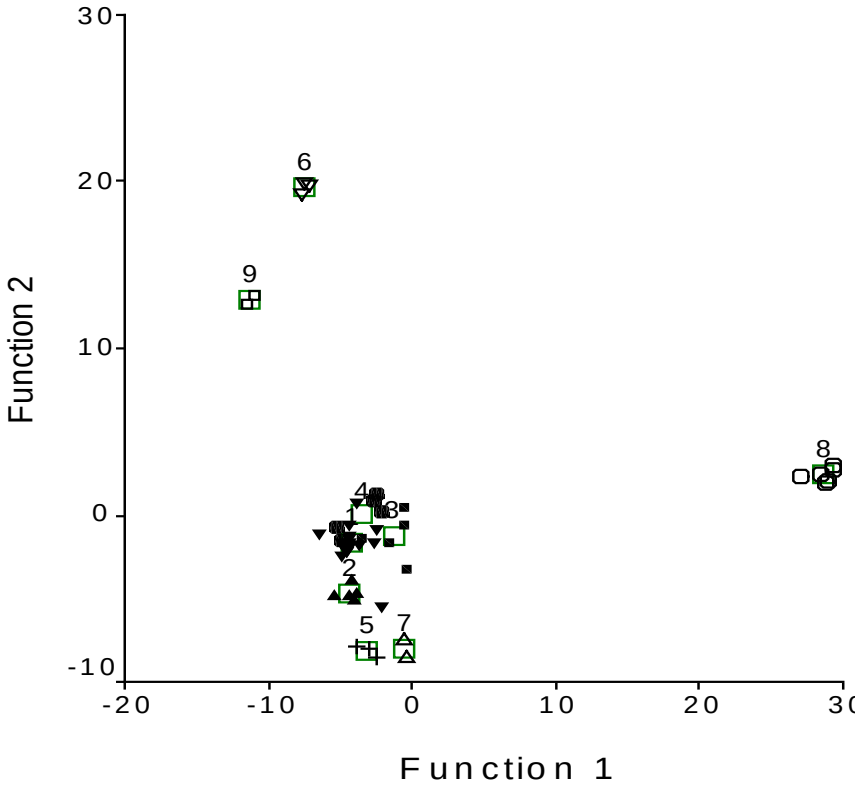

Figure 4: The spatial clumping of guilds according to the collective abundance construct of their species members

IV. Discussion

In this paper whether community structuring in to guilds makes sense in real field scenario was investigated. Members of a guild were determined on the basis of their natural adaptive features and known niche requirements and the investigation was whether this determined collective response to resource or factors underlying the mode of existence of resource including interspecific competition was the object of the investigation. To summarize the results bird guilds classified apriori were utilizing the forest in a manner that reflected the number of available habitat niches within the forest. All members of a guild were going for the same types of patches which can be considered as a measure of interspecific niche overlap. This can be taken as evidence that interspecific competition was higher within a guild than amongst guilds and together with the distribution of the collective niche of species it determined the structuring of the bird communities in to 9 guilds in a real field scenario. Furthermore the results indicated birds have tight interactive relationships with bottom processes as consumers higher up affecting them and being affected by them. The models presented can be taken as evidences of birds shaping the mode of existence of bottom biota and vise versa.

The results in this paper can be interpreted as the collective numerical response of the forest bird community to habitat quality which is taken as a segregation of collective abundance construct of the community as result of changes in habitat quality. This indicates there is a community total numerical response to habitat quality which indicates as much as the birds are affected by what offered naturally along certain habitat gradients they too affect habitat as consumers of all sorts of life components in this forest ecosystem shaping the states of the various attributes of the natural system. Such bottom-up and top-bottom interactions are vital in making sure a forest ecosystem such as this is productive and birds paly pivotal role in making sure the right and favorable conditions are met in such an ecosystem that maintains the balanced cycling of goods and services rendered to humans by such a pristine system as determined by Shimelis (2016) and Shimelis (2017a,b,c).

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27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

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29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

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- Reason of the study - theory, overall issue, purpose
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- Significant conclusions or questions that track from the research(es)

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	A-B	**C-D**	**E-F**
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Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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