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Cover image: ***Flemingia macrophylla (Willd.) Merr..***

Description: The dried pods of Flemingia macrophylla (Willd.) Merr. are rusty tomentose, consisting of glandular hairs which yields orange color dye.

Locality: Melghat Tiger Reserve, Maharashtra, India

Distribution: Nearby areas of Raipur village, Dist. Amravati, MS, India

Photo By: Dr. Dhole Pankaj A, Scientist, Central Botanical Laboratory, Botanical Survey of India, Howrah 711103, India.

Contents

REVIEW ARTICLE

The Fatal Fang: did stress-induced Xerostomia evolve as a strategic offensive/ defensive weapon in hominid combat?

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ABSTRACT

The lack of the traditional natural weapons of combat-horn, claw, extended canine, talon, venom etc. has forced the human species to develop a rather novel and unorthodox biological weapon, namely stress-induced xerostomia, or a reduction in salivary flow into the oropharyngial cavity, during those times of psychological stress that are the usual prelude to combat. Since one of the immunologic functions of the saliva is to keep down the number of micro-organisms in the oral cavity, this reduction of salivation immediately results in a marked increase in the bacterial population of the mouth. Since bites are frequently inflicted in combat between humans, this would result in the inoculation of a substantial bolus of pathogenic micro-organism into the bite wound of the opponent, the subsequent setting up of an infective nidus at the bite site, and thus either in fever/sickness or a severe festering wound necessitating, not infrequently, in a need for frank amputation of the affected digit. In any event the combat ability of the opponent will be substantially reduced as a result. It is therefore likely that there has been a substantial Darwinian selection for this peculiar physiologic trait of a desiccation of the mouth during times of inter-personal stress, when the likelihood of there being a physical conflict between humans rises substantially.

Keywords: Xerostomia, hominid combat, stress, bite, infection, bacteria.

INTRODUCTION

Humans are unfortunate in that unlike most other species that can rely on an array of bristling weaponry be it extended canines

claws, hooves, spines, horns etc, they possess a negligible repertoire of bodily weapons. In addition, they have neither a thick matting of whole body hair or fur to cushion a blow nor a hard cornified exoskeleton or dermal armor that would shield them from a bite, a stab, or a piercing horn. The notorious propensity of humans to engage in combat on the most inane of pretexts only aggravates the situation both for the aggressor and the defendant. Clearly therefore, in the course of human evolution, in the pre-historic era before stone tools/weapons were invented, there was an imperative need to devise some natural weapon that would give both the combating parties an edge over the other. It appears that such a weapon was indeed evolved, but whose existence, let alone remarkable effectiveness - as will soon be demonstrated - has not been appreciated until now. This is the weapon of fear/ anxiety stress-induced oral xerostomia – the "dry mouth" syndrome.

Oral bacteriology:

The oral cavity, under normal conditions, is a seething cauldron of pestilence, housing nearly 190 aerobic and anaerobic bacteria species, some dangerously pathogenic, in its innards (Revis, 2009). The warm environs of the mouth, at a steady 37^{o}C, the availability of trapped food detritus on and in-between teeth, all connive to greatly facilitate bacterial growth. A milliliter of saliva taken from the mouth under normal healthy conditions bears nearly a 100 million bacteria(Revis, 2009). These numbers, while impressive, actually belie the fact that the mouth is in fact substantially under-colonized and can potentially sustain a far greater number of bacteria. That it doesn't owes to the rather remarkable fact that human saliva is actually an unusual liquid with marked antibacterial properties. The sweet breath of the drooling baby owes to the excessive and copious saliva it secretes, which decimates malodor producing bacterial numbers, while the frequent bad breath(halitosis) of the adult human – as most of us are regrettably only too socially aware - is due to a reduction in this flow, which raises the population of odor producing bacteria in the mouth.

The salivary fluid is secreted into the oral cavity on a chronic basis from the three salivary glands, namely the parotid, the sub-mandibular and the sub-lingual, whose combined output amounts to about 1.0 ml per minute(Hightower *et al*., 1973a). Apart from its obvious function of lubricating the mouth, permitting the mastication of food, the enabling of fluid speech, facilitating the digestion of carbohydrate via the ptyalin enzyme that it contains, the saliva performs a less obvious but equally critical function, namely holding down the bacterial populations of the mouth. This it accomplishes through a range of bactericidal and bacteriostatic substances it contains. Firstly, there is the enzyme lactoperoxidase which is capable of generating singlet oxygen, an extremely powerful oxidizing agent that is inimical to bacteria (Brock, 1979). Singlet oxygen is an extremely powerful oxidizing agent generated from ordinary (triplet state) diatomic oxygen when the two electrons present in the two anti-bonding orbitals (π_{2p}*) have opposite spins, as opposed to the identical spins they have in triplet oxygen. This highly reactive configuration gives singlet oxygen an indiscriminate tendency to violently react with, and destroy, any organic substance such as a bacterium in its vicinity (Sharpe, 1992). Secondly, another enzyme called lyzozyme is also present in the saliva and is capable of bringing about lysis of the protective cell walls that surround a bacterium. Among the oral bacteria destroyed by lysozyme are those of the genera *Staphylococcus, Streptococcus, Micrococcus, Proteus, Brucella and Bacillus* (Hightower *et al*., 1973b). Lysozyme is present at a concentration of about 72.9 micrograms per milliliter (Jenzano *et al*., 1986). Finally the saliva contains the antibody Immuno-globulin A, that has a mass between 180-500kd, and which is secretes into the saliva from the blood by the aid of a protein called the Secretory Component. This antibody is capable of binding to

antigens present on the surfaces of bacteria, and the resultant antibody-antigen complex then serves as a molecular attractant signal for the homing in of the macrophages and neutrophils, which are phagocytic cells, into the oral cavity that then proceed to destroy the bacterium (Stryer, 1995). Acting in concert and synergistically with chaotropic ions present in the saliva, this tripartite defense is capable of substantially reducing the bacterial population of the oral cavity, which is why, in the healthy, non-stressed individual, the oral cavity is by and large non-odoriferous.

The primary points of adhesion of bacteria in the oral cavity are the teeth. Even within a few hours of a tooth being thoroughly cleaned and rendered bacteria free, bacterial colonies are evident under microscopic examination of the tooth surface. These colonies then begin to expand exponentially. This is due the formation of dental plague, which is composed of filamentous bacteria such as *Leptotrichia buccalis*, Streptococci, Diphtheroids, Gram negative cocci etc, embedded in an polysaccharide matrix, the entire composite being called a dental plaque (Brock, 1979). The speed of colonization is breathtaking. If the mouth remains un-brushed and there is no evidence that the early hominids practiced any sort of oral hygiene such as the tooth brushing that we practice today the surface area of the plaque rises from 1,436mm^2 to 22,522mm^2 within 240 hours (Lang *et al*., 1972). Yet even this dramatic rise results in the colonization of only about 50 percent of the tooth surface, the bacteria being held at bay in their expansion by the salivary antimicrobial agents afore-mentioned. The friction of the surface of the tooth against the surrounding tissue during a bite event will thus result, via scraping abrasion, in an injection of a substantial bolus of this plaque into the wound, with potentially infective consequences.

Stress-induced Xerostomia

Now it is a well established fact that in the human, any severe psychological stress, be it anxiety, fear or apprehension, can and does immediately bring about a reduction in the flow of the salivary fluid (Bell *et al*., 1963; Bergdahl, 2001). In addition the levels of lysozyme and IgA in the saliva are decreased in individuals under psychological stress (Yu Shan-fa *et al*., 2008; Ng *et al*., 1999; Graham *et al* 1988; Henning *et al*., 1992). This reduction in the flow of saliva is called xerostomia. And its immunologic consequences are as swift and instantaneous as they are serious. Since the typical bacterial division time is only 20 minutes, and since bacterial multiplication proceeds by as an exponential increase, bacterial numbers , which hitherto had been held in check by the antibacterial components of the saliva, now explode into rampant and unrestricted proliferation; and the oral cavity, within a matter of hours, is converted into a cesspit of swarming bacterial colonies. So severe indeed are the deleterious effects of long-term xerostomia, that if the condition is not swiftly corrected it can result in severe dental caries, gingivitis, candidiasis of the mouth, inflammation of the tongue, (glossodynia) and ulceration of the buccal mucosa (ADA, 2000; Astor *et al*., 1999; Greenspan,1996; McDonald *et al*., 1991; CDHA, 2000; Flynn,1993) all as a result of the un-inhibited proliferation of the oral bacteria and fungi, such as *Candida albicans*, that reach such prodigious numbers now that even the squamous epithelium of the oral mucosa is invaded. The reason for this is that normally a opious outflow of saliva washes away and debrides the dead squamous epithelial lining of the oral cavity, thus reducing the food supply to the bacteria in the mouth. The marked reduction, occasionally total shutdown, of salivary flow in xerostomia results in the retention of this desquamated tissue, providing a rich nutrient supply for the bacteria that now not only coat the teeth but the oral mucosal lining as well (Bell *et al*., 1963). The mouth in short is therefore converted into a deadly dangerous biological weapon, whose potential lethality now extends well beyond the mere *physical* damage inflicted by a bite. In the healthy individual this state of affairs fortunately

does not persist indefinitely but lasts only for the period of the psychological stress. The ubiquity of this peculiar phenomenon of a psychogenic stress -induced desiccation of the mouth has, incidentally, been well recognized by writers of thriller novels worldwide. There is hardly a thriller novel in print that does not have the phrase "his mouth turned dry in fear" at some point or other in its narrative, a hackneyed cliché that has been over-used in the fiction book-trade, but which nonetheless accurately reflects physiologic fact; and, as we shall now see, a preparation for battle.

The Toxic tooth as a weapon of combat:

What makes xerostomia pertinent to the central thesis of this paper is that the conversion of the hitherto relatively clean mouth into this "foul mouth" condition, under the conditions of the psychological states of fear and anxiety, that were the prelude to hominid combat in the ancient past, is that the mouth is frequently used in overt aggression to inflict a bite – causing the so-called occlusive injury. And since in a fight the hands are typically extended to either grasp the opponent or strike him, the hand is the site that receives the bulk of bite wounds compared to other parts of the human anatomy. For instance, over a six year period, there were more than 115 visits to the Emergency Department of a Rhode Island hospital for the treatment of bite injuries (Merchant, 2005). And this percentage in all likelihood represents a gross underestimate. The fear of social embarrassment and the even greater risk of legal action keeps a great many of such bite incidents under-reported. The presence of the aforementioned teeming hordes of infective bacteria in the xerostomic mouth, converts the hitherto relatively innocuous mouth and its 32 teeth into a potent weapon of war. It has been found that over 15% of all human bite wounds turn infectious (Revis,2009). Far more ominous is the fact that in the pre-antibiotic days, nearly 20% of all bitten fingers which, as mentioned, is usually the bite site in fighting humans - had to be amputated if the hand was to be saved from the spreading infection(Revis, 2009). Since antibiotics were obviously un-available in the pre-historic past the remarkable effectiveness of this "foul mouth" weapon is dramatically underscored, and provides a resounding endorsement of the hypothesis that the stress-induced xerostomic syndrome arose in hominid evolution exclusively for the purpose of combat, and substantially leveled the playing field between two combatant of unequal size. A hominid that lost his finger, or worse, hand, as a result of such an infection isn't very likely to throw a punch in any haste in the future. It must be borne in mind that even amputation of the affected finger, as was required in the pre-antibiotic era, in order to prevent the proximal spreading of the infection, is a highly skilled surgical procedure that was not therefore available to the earlier hominids. In such a situation it would be predicted that there was a spreading of the infection to the rest of the body potentially resulting in death of the hapless hominid. The power of the bite in producing serious injury is highlighted by the fact that the masseter muscle of the jaw - which, acting in concert with the temporalis muscle, is responsible for the closing of the jaws (Jacob *et al*., 1982a) - *is the strongest muscle in the body* if the shortness of its lever arm is taken into account, capable of exerting a force of 444Kgs, or 4351.2 Newtons ! (McFarlan *et al*.,1992).

What makes this unorthodox biologic weapon so effective is that a bite does not have to be inflicted in order to inimically affect the opponent. Even in the passive situation where the xerostomic human does not have an opportunity to bite but instead receives a clenched fist blow to the face, the cutting action of the frontal incisors or lateral canines on the striking knuckle is capable of causing a severe enough cut (3 – 8 mm in length) to set up an infective locus. Indeed so common is this form of injury that, in the parlance of the hospital ward, it is called a clenched fist injury. And it is just as effective of causing a serious ingress of oral pathogens into the cut knuckle, as the frank, uninhibited bite (Revis, 2009). If the

tooth is partially broken under the force of impact all the better, for the jagged edge of the broken surface will produce an even more severe and deeper laceration and thus a greater deposition of bacteria into the wound. Indeed, in a famous criminal case where a bellhop in a high class hotel had killed a patron when surprised in the act of stealing, it was precisely such a wound that lead to his capture. For the closed fist blow to the woman's mouth while proving lethal to her, also resulted in a tooth grazing injury to the murderer's fist; and when he sought medical attention for the injury, that had turned infectious, he was readily apprehended.

The marked potency of the bite in producing a suppurating infection of the bitten hand is due primarily to the activities of two bacterial species of the many species transferred in the bite event - *Eikenella corrodens* and *Staphylococcus aureus*. The former is an aerobic, Gram-negative bacterium that is capable of causing a persistent infection and abscess formation at the wound site, while the latter, also an aerobic species, intensifies the severity of the infection and enhances the post-trauma complications developed at the injured zone (Revis, 2009). Among the other bacteria found in the injured tissue are the anaerobic Bacteroides species, Enterobacter, Klebsiella, E. coli, Proteus and Pseudomonas (Mann *et al*., 1977; Goldstein *et al*., 1978; Bilos *et al*., 1978; Shields *et al*., 1975). What makes the hand particularly vulnerable to a bite injury is its peculiar anatomy. The dorsal (upper) surface of the hand that is the surface opposite to the palmar surface is a very exiguous structure, with a but a very thin layer of protective fat. Thus during a clenched fist injury to the hand, several possible destructive scenarios can unfold. First the Metacarpophalageal (MCP) joints of the five fingers, what in layman language are called "knuckles", which are the "hinges" between the metacarpals (the five cylindrical bones radiating out from the wrist region to the five knuckles) and the phalangeal bones of the fingers, are completely exposed, with but layer of skin covering them, and the impacting tooth can thus either easily shatter the joint or tear through its protective capsule and deposit the bacteria directly in the joint cavity itself. Since the middle finger MCP joint is the largest it tends to bear the brunt of the impact and is the one most often damaged. The resultant infection, is on occasion so extreme that the joint can no longer be flexed. Secondly, if the fist smashes into the tooth on the phalangeal surface the phalanges can be broken, and the broken ends of the bone exposed to the exterior.

In the case of the occlusive bite, the injury can, of course, occur on either the dorsal(upper) or ventral (i.e. the palmar) surface of the hand and the deposition of the bacteria can occur via the multiple tooth puncture wounds on these two surfaces. What makes the hand so particularly vulnerable to infection is that it is not only poorly vascularized, thus preventing the immune part of the blood circulation from accessing it, but in addition, the bacteria inoculums, as they multiply, can spread along the tendon sheaths to other parts of the hand and set up further infective loci. The hand in the vicinity of the fingers has very little musculature and the action of the proximal flexor muscles in the forearm such as the Flexor digitorum superficialis is transmitted to the phalanges of the fingers via the flexor tendons, or in the case of extender muscles like the Extensor indicis muscle via the extender tendon(Jacob *et al*., 1982b). Thus once the skin is penetrated by the tooth and the bacteria are deposited in the cut, the bacteria multiply and expand to the flexor and extender tendons. In addition the flattened anatomy of the hand results in its muscles being present in several layers (Jacob *et al*., 1982c), and thus the infection can spread proximally (i.e in the direction from finger to wrist) via the gaps present between these tissue planes. In addition there are two sets of muscles present in the hand itself. These are the lumbrical muscles present on the palmar side of the hand and the Inteosseous muscle present between the forefinger and the thumb. These muscles are surrounded by sheaths the so-called interossei and lumbrical sheaths

which regrettably can also serve as conduits by which the infection can spread from the bite site to the rest of the hand (Mann *et al*., 1977). As the wound festers the hand turns painful and tender and may discharge a malodorous pus (Welch, 1936). The patient frequently develops chills and a fever as well (McMaster, 1939). The tendons of the hand are enclosed in sheaths called tendon sheaths *within which* the tendon slides, and one of the complications of the infected hand develops when these sheaths become so inflamed that the tendon can no longer slide freely within its annular jacket. This pathological phenomenon is called Tenosynovitis, and when it affects the tendon sheaths of the flexor tendons it can progress to the point where it is no longer possible to extend the finger, the finger remaining locked in the flexed curled position in what is aptly and colorfully called "the trigger finger". (Jacob *et al*., 1982d; Cartoto, 1986).

This form of clenched fist injury to the striking assailant may also help clear up a long standing evolutionary mystery. A peculiar physiognomic feature of *Australpithecus afarensis* is the prognathous jawline, with the frontal incisors and canines projecting outward at so sharp an angle from the maxilla and the mandible as to give this extinct hominid a most unsightly "buck-tooth" configuration (Boaz *et al*., 1997a). While aesthetically unpleasant, this configuration of the frontal tooth-line would be expected to have considerable defensive value. In the modern human the orthognathous configuration of the face results in the frontal teeth having virtually a near vertical disposition, such that the striking fist will slam into the tooth surface on its *flat broadside* rather than on its sharp edge. This regrettable disposition, while causing negligible injury to the clenched fingers of the aggressor, will impose such a severe mechanical stress what, in the terminology of engineering, is called a "bending moment" on the tooth surface as to essentially knock it out of its socket, as more than one schoolboy, who has been forced to get a set of false replacement teeth after a fight, has discovered to his chagrin. The unique defensive power of the Australopithecine frontal teeth on the other hand derives from the fact that they project so sharply outward, at an angle of nearly forty five degrees to the horizontal (Boaz *et al*., 1997a), that the *likelihood of the fist in its swinging arc striking the sharp edge of the tooth rather than its flat broadside increases dramatically.* This has two consequences. Firstly, since the tooth experiences a force, a substantial cosine component of which is directed *inwards* into the gum cavity, along the longitudinal axis of the tooth, the probability of the tooth being smashed out of its anchorage is diminished. And this is an important consideration, for the loss of one or more teeth in combat, in a species that , not having access to fire (Boaz *et al*., 1997b), was forced to eat very hard and tough food material, would have disastrous consequences for its survival. Equally importantly, since the outward knuckle surface now will come in contact with the sharp edge of the tooth, the depth and severity of the injury to the hand of the offender will be far more serious, the resultant infection the more intense. It would be tantamount to punching into the sharp edge of a held knife - not a very pleasant thought and an even less pleasant sensation and outcome. The pugilistic wisdom of the Australopithecene "buck-tooth" is thus readily evident. This might have been particularly relevant in the case of *Australopithecene gracilis*, rather than *Australopithecine robustus* since the more delicate structure of the cranial vault and associated facial bone structure would render the former much more vulnerable to a blow to the facial region (Boaz *et al*. 1997c).

The bite as a offensive weapon was probably even more effective in the more ancient ape-like hominids such as *Ardipithecus ramidus* (circa 4.4Mya) that had more extended upper and lower canines(Boaz *et al*., 1997d) which would give a greater depth of teeth penetration and thus the deep-seated deposition of a greater number of bacteria into the wound. Indeed, so large and prominent are the canines of this hominid compared to the post-canine teeth that they resemble more fangs than teeth, converting

the canine tooth literally into a potentially fatal fang.

CONCLUSION

The feral bite is a mode of combat with an ancient and time-honored pedigree. Other species closely related to humans such as the chimpanzee, the gorilla, and the Old and New World monkeys frequently bite each other - and regrettably also humans when raised as pets – during conflict situations. For instance, nearly 80% of Macaques secrete the *Cercopithecine herpes virus* – 1(B-Virus) into their saliva (Ostrowski, 1996). This shedding of virus, which increases when the animal is under stress, (Weigler,1992) can cause a meningoencephalitis in bitten humans, sometimes so severe in manifestation as to result in either death (Ostrowski, 1996) or marked neurologic impairment and the permanent institutionalization of the patient (Palmer, 1987) . Hence there is the real possibility that the xerostomic mouth as a mode of offense/ defense arose very early in the evolution of the primate family; indeed its antecedents might well lie much earlier to the Hominidae. How much earlier, if such is the case, is unclear for the incidence of xerostomia in non-human primates has not been rigidly quantified. The fact that nearly 20% of all male chimpanzees die in combat only serves to underscore the gravity of the situation.

With the advent of the Bronze Age and the invention of the classic weapons of war, it is likely that this uncouth form of defense and offense rapidly became obsolete. The fact that in the modern day setting subjective feelings of anxiety and fear easily and routinely evoked in a multitude of social situations such as preparing for exams, appearing for job interviews, delivering a public speech, going out on a blind date - still evoke dryness of the mouth clearly bespeaks the activation of an atavistic mode of defense; a regrettable and counter-productive activation that no longer serves any useful purpose. Furthermore, the rise in the incidence of HIV AIDS has brought this issue to the fore. Since HIV in its latter stages affects brain function, at which point primary social inhibitions are lost, and since a great many of these patients come from the impoverished, marginalized section of society, frequently needing to supplement their income and medical bills by crime, their apprehension by law enforcement personnel poses a grave risk, for in the tussle of being apprehended it is not unknown for the convict to threaten to bite the law officer, full aware of the disastrous sequelae that will follow. And it is a threat not to be taken lightly coming as it does from a person who does not have much longer to live anyway, and thus has little to lose by taking liberties with the law.

The novelty of the highly infectious xerostomic mouth, as a combat weapon, should not obscure the fact that it, in fact, represents a re-discovery by the primate(?)/human species of a mechanism that is far more ancient. On the islands of Komodo, Gili Dasami, Flores and Rinca in Indonesia exists a reptile, the ill-famed Komodo Dragon, that uses precisely this form of attack in bringing down its prey (Ciofi, 2004). The foul, saliva dripping, mouth of this beast, whose lineage extends back to the Jurassic, teems with bacteria of such lethal potency, such as *Pasteurella multocida*, that a single bite of the dragon on the body of the ambushed prey animal is enough to ensure its doom. The injected inoculum works on the hapless beast over a period of days, while the komodo bides its time. And as the bacterial population in the wound skyrocket and invade the blood stream in prodigious septicemic numbers, the animal progressively becomes weak, falls immobile, and, within a few days after sustaining the bite, is dead (Auffenberg, 1981; Montgomery *et al*., 2002). It is a simple matter for the dragon to then waddle up to the now putrid carcass and feed off it at leisure, the highly toxic bacteria laden innards of the dead animal having no effect on the dragon itself. This remarkable impunity to these bacteria is critical for the survival of the dragon, for the "foul mouth"

condition is chronic and ever-ready for deployment; the festering putrefying condition of the oral cavity sustained by the rotten fragments of meat trapped in the tooth crevices which provide an effective culture medium for the bacteria. So powerful and potentially lethal are these bacteria that though the beast has no natural predators on the island that it needs to fear, its entire exterior is covered with a thick and impervious keratinized armor, so hard that a hand run over it returns the tactile impression of chain-mail. The function of this remarkable armor is simple to shield the komodo dragon from its own kith and kin, a single bite of which can well turn the beast into a meal for its compatriots.

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RESEARCH ARTICLE

Molecular detection of endosymbiont bacteria *Wolbachia* in bedbug species *Cimex lectularius* from Vidarbha region of India

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ABSTRACT

Wolbachia are maternally inherited bacterial endosymbionts that found in different arthropods. It is now well known that they induce reproductive phenotypic manipulations like feminization, thelytokous parthenogenesis, male killing and cytoplasmic incompatability in their arthropod hosts. Although diverse insects are infected with *Wolbachia* bacteria and generally for their insect hosts, it is regarded as facultative/parasitic endosymbiont bacteria. The *Wolbachia* strain, designated as wCle associated with the bedbug *Cimex lectularius* was shown to be vital for the growth of host's and reproduction via provisioning of B vitamins. Previously the infection of endosymbiotic *Wolbachia* bacteria has been shown to the colonies of the human bed bug, *Cimex lectularius* L. (Heteroptera: Cimicidae) cultured in the laboratory, but no information exists regarding the infection status in natural populations in India. We assayed *Cimex lectularius* populations from different areas of Vidarbha region (Akola, Amravati, Chandrapur,Nagpur), Maharashtra, India for *Wolbachia* infection. Detection was done by the polymerase chain reaction (PCR). *Wolbachia* infections were prevalent in all populations assayed (75–100%). Higher rate of *Wolbachia* infections were found in bedbugs of Vidarbha region of India, which indicates importance of this association. The characterization of these *Wolbachia* strains provides a deeper approach into this interaction, which is essential for further studies. The potential utility of *Wolbachia* for another bed bug control strategies is discussed.

Keywords: *Wolbachia, Cimex lectularius* , PCR

INTRODUCTION

Wolbachia is the maternally inherited and intracellular endosymbiont bacteria found in diverse arthropods and filarial nematodes. This bacteria is known to transfer vertically as well as horizontallyacross different hosts. The host population can be influenced by *Wolbachia* with different reproductive alterations such as cytoplasmic incompatibility, male killing, parthenogenesis, speciation and feminization (Salunkhe *et al.,* 2014; Werren *et al.,* 2008).Various reports findings said that the infection of *Wolbachia* was observed in 15–25% of insect species (Salunke *et al*., 2012 and Werren *et al.*, 1995) which was reworked to 40% according to a meta-analysis by Zug and Hammerstein (2012). Members of the genus Wolbachia is well known as facultative bacterial endosymbiont bacteria that is associated with different insects, generally conferring negative fitness consequences to their hosts and to enhance their own transmission in a selfish manner it often causes aberrations to the host's reproductive system (Hilgenboecker *et al.* 2008; Werren *et Al.,* 2008). However, a Wolbachia strain associated with the bedbug *Cimex lectularius*, designated as wCle, was shown to be essential for normal growth and reproduction of the bloodsucking insect host via provisioning of B vitamins (Hosokawa *et al*., 2010). *Wolbachia* is estimated to infect up to 70% of all known insect species, making it perhaps the most prevalent symbiotic bacterium on the earth ecosystem (Jeyaprakash and Hoy, 2000).

Hemiptera, an order of class insecta, encompasses bedbug *Cimex lectularius*, insect of the Cimicidae family. Bedbugs are hematophagous arthropods. Medical interest in bedbugs especially *Cimex lectularius* in temperate zones has increased. Adult *C. lectularius* are reddish brown, flat, wingless and ovals (4–7 mm) (Fig.1).

They are hematophagous. They can live for 12 months without feeding and even 1.5–2 years in colder environments. The bedbugs are geographically distributed throughout the world. They may be found in theaters and roots as well as in houses. It affects underprivileged social classes, but also people using collective installations (hotels, trains, dormitories). Cutaneous lesions are the main symptom causes after their bites. In addition, there is no report available on *Wolbachia* infection in *Cimex lectularius* from India so far. Several authors have postulated that these species of *Cimex lectularius* could transmit pathogens to humans (Goddard and deShazo, 2009; Burton, 1963). *Wolbachia*-like inclusions were identified in bed bugs by microscopy almost 90 years ago (Arkwright *et al*., 1921). More recently, Sakamoto and Rasgon

Fig.1. Photograph of Adult *Cimex lectularius* taken by Carl Zeiss Microscope

investigated the geographic distribution of *Wolbachia* infections in natural *C. lectularius* populations in North America and Africa. *Wolbachia* infections were found at high prevalence (83–100%) in all sampled populations (Sakamoto and Rasgon 2006). Thus goal of this study was to survey the eventual presence of endosymbiont *Wolbachia* bacteria in natural population of bed bugs using PCR. Hence studying *Wolbachia* infection in *Cimex lectularius* may provide deep approach into the evolutionary history of bed bug–*Wolbachia* interaction.

In the present study, we show the presence of *Wolbachia* among a sample of bed bugs collected from Vidarbha region, Maharashtra, India belonging to Cimicidae family. Bed bugs were collected from different areas of Vidarbha region, Maharashtra, (Akola, Amravati, Chandrapur, Nagpur) and 70% ethanol is used for preservation. Taxonomic identification of insects were carried out by using identification keys and then we explored the presence of endosymbiont bacteria *Wolbachia.*

MATERIALS AND METHODS

Collection of Bedbugs

The species of bedbugs *Cimex lectularius* were collected during 2013 to 2014 from their natural habitats from different areas of Vidarbha region, Maharashtra, India (Table 1). Bedbug species were collected from home and theaters. The collected species were transferred to the laboratory carefully in collecting vials, identified and separated with respect to their sex.

Molecular detection of Wolbachia infection

The genomic DNA was isolated by the Kit method. The DNA was extracted by the Insect DNA Extraction Kit (Nucleopore Insect DNA Extraction Kit). Molecular diagnosis of Wolbachia was done by Wolbachia-specific PCR assay using specific primers W-Specf (5′-CATACCTATTCGAAGGGATAG) and W-Specr (5′-AGCTTCGAGTGAAACCAATTC). PCR amplification was carried out with Peltier PCR Processor Model NEO (BioEra) using 50 µl reaction volume consisting of 14 µl of master mix (Thermo scientific) (0.05U/ul Taq DNA polymerase, reaction buffer, 0.4mM of each dNTP (dATP, dCTP, dGTP, dTTP) containing 10X Taq buffer with KCL (100 mM Tris-HCl pH 8.8, 500 mM KCl) 0.2 mM dNTPs, 4mM MgCl2, 2.5 mM MgCl2 and 0.5 U Taq DNA polymerase, 100 pm of 3 µl each of forward and reverse primers, 50 ng of 1.5 µl of template DNA, 23 µl of nuclease free water to make up 50 µl. The conditions of PCR reaction consisted of an initial denaturation step at 95°C temperature for 2 min followed by 35 cycles of denaturation at 95°C temperature for 30 sec, annealing at 60°C temperature for 1 min and extension at 72°C temperature for 45 sec and a final extension at 72°C temperature for 5 min. The amplified PCR products were separated through electrophoresis run of 1% agarose gel in 1X TAE (40 mM Tris-HCl, 20 mM acetic acid and 1 mM EDTA)(Puregene genetix brand) buffer for a length of 5–6 cm at a constant 60 V. A standard molecular weight marker DNA ladder (Thermo Scientific GeneRuler 1 kb Plus DNA Ladder) was used in electrophoretic run and the gel documentation system (BioEra's Gel Documentation system, Model Endure) was used to document the gel.

RESULTS AND DISCUSSION

The specific effect of *Wolbachia* on bed bug biology is unknown. We have identified *Wolbachia* infections in *C. lectularius* using PCR. PCR was initially attempted using published primers . Our reports thus suggest that *Wolbachia* infections are most likely common among bed bugs in general.

The major finding of the current study is the presence of endosymbiont bacteria *Wolbachia* that harbour maternally. *Wolbachia* infection is known to cause either feminization or male killing in its host.

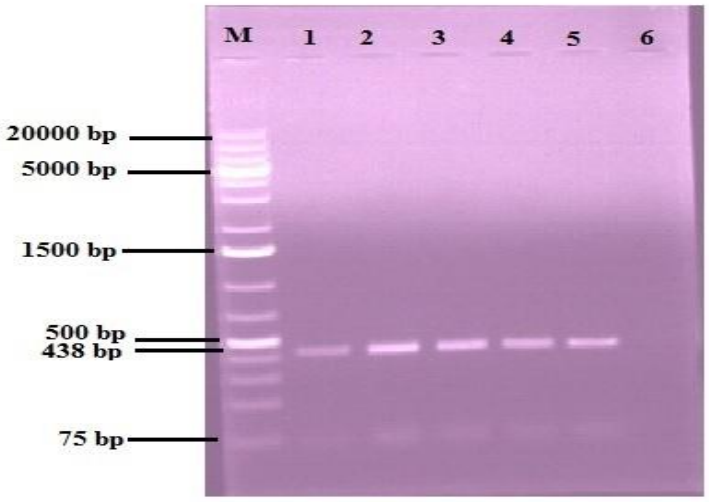

Fig 2. Gel image showing the amplification *Wolbachia* specific wspec primer at around ~438 bp; lane M-molecular weight marker (Thermo Scientific Generuler 1 kb Plus DNA Ladder), lanes 1 and 6- positive and negative controls respectively, lanes 2 to 5- *Cimex lectularius* collected from Akola, Amravati, Chandrapur and Nagpur respectively.

Table 1: The PCR results screening the infection status of *Wolbachia* in *Cimex lectularius* species collected from different areas of Vidarbha region, Maharashtra.

Sr. no.	Areas	Bedbug species	Number of detection *Cimex lectularius*	Body part used for DNA isolation	Positive Wolbachia
1	Akola	*Cimex lectularius*	18/20	Abdomen	+
2	Amravati	*Cimex lectularius*	15/15	Abdomen	+
3	Chandrapur	*Cimex lectularius*	14/18	Abdomen	+
4	Nagpur	*Cimex lectularius*	15/20	Abdomen	+

Historically, *Wolbachia*-like inclusions were observed in other cimicids besides *C. lectularius* and were identified by PCR (polymerase chain reaction) in the cliff swallow bug *Oeciacus vicarius* Horvath (Rasgon and Scott 2004). A total of seventy three individual of *Cimex lectularius* a bedbug species were screened in the present study for *Wolbachia* infection by PCR amplification (table 1) from different region of Vidarbha. And the results revealed that out of seventy three individuals of *Cimex lectularius* sixty three individuals were found to be infected with *Wolbachia*. This is a primary data on the infection status of Wolbachia in the species of bedbug *Cimex lectularius* from different area of Vidarbha region. In the PCR assays for *Wolbachia*, a PCR product of the expected size (~438 bp) (Figure2) was obtained from all individuals tested. In diagnostic PCR assays, positive and negative control samples were used for checking the impurities or false results as expected in all the diagnostic PCR assays.

The association may be a symbiotic type in which this intracellular proteobacterium may play a key role in the digestive and reproductive functions of

bed bugs (Sakamoto, 2006) . Thus an indirect and alternative strategy of fighting against bed bugs could consist of killing Wolbachia species, because they may be necessary for the survival of the bugs.

Our results confirm that *Wolbachia* species is a frequent commensal of bed bugs (62 / 73) in table 1. As yet there has been no information available regarding the Wolbachia infection status in *Cimex lectularius* from Vidarbha region of India. This will be the first report from Vidarbha region of India.

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RESEARCH ARTICLE

Preliminary investigation for first time on blue snapper *Pagrus spinifer* (Forsshal, 1775) of Mithbav Creek of South konkan, sindhudurg, Maharashtra, India.

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ABSTRACT

Blue snapper, *Pagrus, spinifer* is habitant of Mithbav creek (L.16^0 20' N.L. 17^0 25' E) Sindhudurg district, Maharashtra, so far there is no work carried out in India. It is commercially and high prized fish available throughout the seasons. It is always found in school condition except in mansoon. It is carnivorous and benthic feeder. It feeds on crustacean, fish, clams, even on human faeces. It is found in deep water lined with rocky-regions. Snapper spawn is observed during the month of May-June with cloudy atmospheric condition in rocky region. The Juvenile can be found around inlets bays and other shallow, sheltered marine water, often over mud-flat. The coastal natives popularly call as 'palu'.

Keywords: Palu, snapper, Mithbav.

INTRODUCTION

The blue snapper belongs to the family sparidae, in the order of perciformes. It is commonly called sea breams and porgies. *Pagrus spinifer* is a highly resident, demersal species that occupies a wide variety of habitat including rocky reefs, sandy, muddy bottom and about 5-10 m. depth in Mithbav creek. All the spines of dorsal fin are tough. Three spines are in anal fin. Adults of this species aggregate over rocky reefs while juveniles are abundant in estuaries and also around shallow coastal rocky reefs and over sandy substrates. This species is an important predator in shallow reef as well as sandy region. During high tide, they easily migrate in this creek but highest recruitment is

observed in extremely high tide time. It is very sensitive to oxygen in cloudy atmosphere, because the diffusion of atmospheric oxygen decreased in deep water hence they move toward the shallow places in group to gulf the atmospheric oxygen. Their breeding and spawning is in the month of May-June. When this time the salinity reached to maximum and atmosphere is cloudy. They spawn in rocky regions; this situation is well known to the coastal native therefore they fished them on large scale.

The Juvenile reached to 2-3 inches in length during the month of july and fully grown is of 30-35 cm.L. and 20-25 cm. H. formed within two year period. The sexual maturity reached at the age of one year growth. Body of the *Pagrus spinifer* is robust oblong, moderately compressed, upper profile of head convex with a buldge above the eye. Lower jaw slightly shorter than upper. The mouth is projected interiorly for search of benthos in the sandy region. Head and upper body is dark silvery blue, sides and belly also blue. The scales are moderately large, dense and firmly attached to avoid the injury in rockly reefs during feeding activities, Dorsal fin usually having 10-15 spines and soft rays 10-15, Maxilla hidden by a sheath, when mouth is closed. Branchiostegal ray six, caudal fin forked but greatly lobed. The proximal part of the caudal fin is dark while distal margin white. The jaws containing heavy molariform teeth, these robust teeth allow them to feed on hard bodies of prey such as small shellfish and other benthic invertebrates.

The life process is slightly disturbed in mansoon due to rain fall. In monsoon due to fluctuation of salinity and temperature, drastically make the effect on their food and feeding habit. The major fishing in this creek is carried out with help of cast net, gill-net, long-line and advan. In pre-monsoon, due to shortage of sea fish, the coastal people plough the shallow sandy region of the creek and after full high tide spread the net on circularly arranged wooden poles. During high tide, blue snapper are attracted toward this soft place for easily available food present in the soil. The highest fishing is done in the month of May-June because of snapper gather for breeding in large number.

MATERIAL AND METHODS

Monthly samples of *Pagrus spinifer* have been collected from December 2013 to November 2014, from Mithbav creek of south Konkan- The fresh specimens were collected for investigation in all the seasons. The percentage composition of gut contents were determined by using the point method. The contents were fixed in 4% formalin.

RESULTS AND DISCUSSION

A preliminary objective of the study was to determine whether or not the blue snapper feeds on bottom dwelling organisms or animals which may be consumed while up in the water column. Table 1 gives various food items which are divided into three categories, like benthic, semibenthic, and nektonic expressed by volume and frequency of occurrence. The semibenthic category contains food organism which may be nektonic but some associated with the substrate.

Ten specific food items were found in the digestive tracts of blue snapper. These include seven Genera of fish and seventeen taxa of invertebrates. Invertebrates consisting mainly of crustaceans, echinoderms, molluscs, annelids were the dominant foods of adult fish occurring in 80-85% of the stomachs. The pelecypod molluscs, sea-urchin, *Scylla sp., Portunus* sp., *Dotilla* sp., and fiddler crabs were occurred most frequently and contributed 57% of the total food volume. The crabs were the most diverse group of food organisms found in stomach.

Table 1 : Seasonal occurrence of food items of *Pagrus spinifer* in the coastal area of Mithbav.

Food categories	Monsoon %	Post- Monsoon %	Pre-Monsoon %
Polychaete	12.14	14.17	17.12
Crustaceans	32.05	30.12	28.15
Human faeces	2.17	03.15	04.18
Fish larvae	10.12	05.18	16.10
Fish	14.13	17.18	10.09
Eggs	03.18	01.15	09.29
Mollusks	02.19	12.15	18.17
Animal Derivatives	11.73	02.58	02.61
Detritus	05.17	06.12	02.17
Algal Material	07.12	08.21	02.12

Table 2 : Qualitative analysis of gut contents of *Pagrus Spinifer.*

Food Item
Fish
Therapon spp.
Sillago spp.
Mugil spp.
Gerres spp.
Anguilla spp.
Ambassis spp.
Cynoglossus spp.
Decapods
Scylla. Spp.
Portunus spp.
Dotilla spp.
Uca spp.
Penaeus spp.
Annelids
Polychaetes.
Echinodermata
sea urchin
Star fish
Sea cucumber
Brittle star
Molluscs
Meretrix meretrix
Meretrix casta
Katelylsia spp.
Solen spp.
Perna spp.
Balanus spp.
Natica picta
Littorina spp.

Fig. 1: Blue snapper *Pagrus spinifer* (Forsshal, 1775)

During high tide, maximum population of blue snapper recruit in the creek for feeding purpose only. The exposed area of the creek during low tide having large numbers of crustacean species which are buried during high tide. Therefore, during high tide, the blue snapper attracted toward this areas only for feeding on pea crabs, *Uca* spp. *Dotilla* spp. and polychaetes worms. The anterior part of the mouth is elongated which help in removing the hidden prey in the soft soil. The clams like *Meretrix, Kalylesia* Spp., *Solen.* Spp. also available in the intertidal region. Intertidal sandy region of about 40 feet radius area is ploughed to make the soil soft. It is good for burrowing the prey like *Dotilla, Uca*, Polychaetes worm to make it densly populated feeding ground for *Pagrus spinifer.* The deeply buried organisms also get exposed to the upper zone. The wooden poles are arranged on the circumference, after full high-tide the net is raised up to trap the fauna. The blue snaper school is greatly attracted and easily caught. This process of traditional fishing is popularly known as 'Advan'.

The feeding intensity was noticed high during high-tide, but low in low-tide. In monsoon, due to sudden fluctuation in salinity and temperature the rate of feeding is low. The rate of feeding was noticed high in post-monsoon due to availability of varieties of food items.

Fish were of secondary importance in the diet of adult fish occurring in 20% of the blue snapper and contributed to 15%. The observation were made both in juveniles and adults, to be a very aggressive feeder. They generally seize the food bait immediately when it is presented to them. The bait of intestine of chicken, *Anguilla* spp. Shrimp are liking food items on which they feed voraciously, hence, always used for hand-line and long-line fishig methods. Also, *Pagrus spinifer* possesses strong molariform teeth which enable it to crush less motile armoured forms such as echinoderms, *Scylla, Portunus*, clams like *Meretrix* spp, *Soletellina* spp. and gastropods like *Nerita picta,* their egg cases, as well as eggs of *Telescopium* spp. Thus, the blue snapper seems tobe well adapted to feed on motile forms and also on relatively non-motile organisms.

Variable of seasonal, geographic area and depth of collection had no apparent effect on frequency occumences of food items in the diet while large juvenile blue snapper (10-15 cm) and adults (30-40cm) feed on similar foods, smaller juvenile (less than 4-6 cm) consumed mainly amphipods, copepods, stomatopods, Isopods and annelids.

The *Pagrus spinifer* is an opportunistic browser which feed predominantly on benthos foods. Approximately 70% of the food were classified as strictly benthic organisms and 85% of the volume was animals which are considered to be closely associated with the substrate.

CONCLUSION

Pagrus spinifer is commercially important fish of Mithbav creek. It is a specific indicator of low oxygen content of the habitat. It has high salinity and temperature toterance. The data suggest that the blue snapper has a tremendously diverse diet and that content probably reflects localized forage assemblage rather than a preference for specific food. Bearden and Mckenzie (1969) also noted that feeding of red porgy appeared to be dependent on species availability gather than preference or selection. Usually a digestive tract contained only one to several individuals of a taxon. Only bivalves and small shrimps occurred in large number in pre-monsoon and monsoon season. This type of feeding has definitely selective advantages in fish farming near by the logoons of this creek. It is fast growing and full growth is done in two years duration. The sexual maturity is completed in one year of growth. The rate of fecundity is compared to be always high than others It's breeding season is in the month of May- June in cloudy atmosphere in rocky reefes. During breeding time, they gather in deep water and remain there for longer time. It is really a good model for aquacultural practices in this area.

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RESEARCH ARTICLE

Avian Diversity and Its Conservation in West Chhindwara Region of Madhya Pradesh, India

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ABSTRACT

The present study was carried out in the West region of Chhindwara district of Madhya Pradesh (India) to document the diversity and utility of avian fauna. Many of the wild life species are gradually vanishing from our forest. The biological imbalance created due to disappearance of particular species which have put may problem. The national forest policy 1952 has laid special emphasis on preservation of wild animals. The inhabitants of the region are dependent up to a large extent on wild resources for their remedial needs. The region is rich in avifaunal diversity having 124 species belonging to 17 orders and 46 families. This study will be helpful in developing a comprehensive data base on the faunal resources to strengthen the care system in the area and in conserving the avifaunal resources for the prosperity of the region.

Keywords: Avifauna, conservation, diversity, ecology, disappear.

INTRODUCTION

Diversity of avifauna is one of the most important ecological indicators to evaluate the quality of habitats. Birds are the key species in an ecosystem for maintaining the ecological balance, (Mariappan, 2013). Now-a-days, avifaunal diversity has been decreasing due to the destruction of natural habitats and human disturbances. Random destruction of natural habitats by cutting nesting trees and foraging plants for commercial use of woods and lands are the main factor responsible for narrow down in

avian foraging habitat and their nesting sites. Thus, many species of birds may be forced to inhabit in the urban areas and constrain them to breed there. Birds are essential animal group of an ecosystem and maintain a trophic level. Therefore, detail study on avifauna and their ecology is important to protect them, (Sarkar et al., 2012).

Number of workers studied avifauna of Central India including Madhya Pradesh and Chhattisgarh. The comprehensive list of birds on Madhya Pradesh and Chhattisgarh published by (Chandra and Singh 2004), reported 488 and 197 species respectively. Jayapal et al. (2005) reported some significant records of birds from Central Highlands of Madhya Pradesh. Ghosh et al. (2008) published detailed account, reports altogether 449 species from Madhya Pradesh (including Chhattisgarh). Studies on behavior and breeding ecology of birds are well done by (Kotpal 1992; Ali 1996; Shruti 2008). Talmale et al., (2012) reported 173 bird species from Singhori Wildlife Sanctuary, Raisen District, Madhya Pradesh.

MATERIAL AND METHODS

Study Area

The West Chhindwara Division is situated between the parallels of latitude 21 Deg. 52' to 22 Deg. 42' north and between meridian of longitude 78 Deg. 14' 43'' and 79 Deg. 01' 52'' East. The Division is bounded on the North by protected forest of Hoshangabad and Narsighpur forest Division, reserve and protected forest of East, forest of South Chhindwara Div. on the southern side and protected forest of Betul district on the West. The total area of the Division is 175945.122 hectares. The tract of West Chhindwara Division is plain to undulating and maximum area is hilly and rugged. Main forests of this Div. are confined to ranges of Satpura hills and Chhindwara plateau. The western and north western part of the division is mostly hilly whereas eastern and southern part is mostly plain. The shape of the division is like a big cleft which forms a deep a very narrow valley of Kanhan river which flows towards south and meet the plains of Nagpur. The highest place in the division is in Tamia range, protected forest block at 1211mt. attitude and the lowest place is in Jhirpa range, at 387 mt. attitude.

The study was taken up in the west division of Chhindwara range. The survey work was conducted during the period of 2013 to 2014. Observations were recorded on habit, habitat, soil details of association and other peculiarities. Primary and secondary data were collected. Primary data was collected by field study and secondary data was collected by forest office of west division of Chhindwara. Avifaunal photographs were identified by standard literature, Ali (2012).

RESULTS AND DISCUSSION

The present paper includes 124 species of birds belonging to 17 Orders, 46 families. A list of 124 bird species (Table 1) reported from West Chhindwara Division shown that order Passeriformes is very rich with 45 species and Coraciiformes and Ciconiiformes with 10 and 10 species Anseriformes with 9, Charadriiformes with 8, Falconiformes with 8 Galliformes with 8 species respectively (Table-1, Fig.-2). Most of bird fauna are resident or local migratory to forest of West Chhindwara Division. Abundance of birds show that 45 species are very common (VC), 34 are common, 30 are not rare and 15 are rarely observed to West Chhindwara Division area.

We found that higher bird diversity in forest land than other habitats, which is due to the presence of diversity of herbs, shrubs, grasses and trees in forest land which provided a place for nesting and breeding for different trophic levels of birds. Different season of the year in particular locality not only influence the different types of vegetation but also other biodiversity like animals, birds, insects, fishes, and

microorganisms, particularly birds are sensitive to seasonal changes, because of their breeding and nesting behaviour heavily depends upon climatic factors of the locality (Huston and Huston, 1994). Therefore, some birds are migrating within the geographical region and even from continent to continents for their breeding and nesting (Berthold, 2001). Thus, the birds distribution and their population trends in different seasons of the year.

Table 1: Bird diversity in west Chhindwara Region of M.P., India

S.No	English name	Scientific name	Local name	Family/ Class
1	White wagtail	*Motacilla alba*	Dhovan	Motacillidae
2	Indian ring dove	*Streptopelia decaocta*	Fakta	Collumbidae
3	Pied hornbill	*Anthracoceres coronatus*	Ghanchuri	Bucerotidae/VC
4	Large pied wagtail	*Motacilla maderaspatensis*	Khanjan	Motacillidae
5	Collard bushchat	*Saxicola tarqnata*	Kharpida	Turdinae
6	Blue winged teal	*Anus querquedula*	Khera	Anatidae
7	House swift	*Apus affinis*	Babilo batasi	Apodidae/VC
8	Stone curlew	*Burhinus oedicnemus*	Barsiri	Burhinidae
9	Weaver bird	*Ploceus philippinus*	Baya	Ploceidae/VC
10	Alpine swift	*Apus melba*	Bada batasi	Apodidae
11	Large egret	*Egretta alba*	Bada bagla	Ardedae/VC
12	Blue cheeked bee eater	*Merops superciliosus*	Patringa	Meropidae/VC
13	Blue tailed bee eater	*Merops philipinus*	Bada patringa	Meropidae/VC
14	Redvented bulbul	*Pycnonotus cafer*	Bulbul	Pycnontidae/VC
15	Small minivet	*Pericrocotus cinnamomaus*	Bulal chasm saheli	Campeghagidae
16	Common quail	*Coturnix coturnix*	Bater	Phasiamidae
17	Common crane	*Grus grus*	Saras	Cruidae/VC
18	Black headed myna	*Sturnus pogodarum*	Brahman myna	Sturnidae/VC
19	Chestnut ballied nuthatch	*Sitta castanea*	Kthphodia	Sittidae
20	Velvet fronted nuthatch	*Sitta frontalis*	Kthphodawa	Sittidae/VC
21	Golden backed woodpecker	*Dinopium bengalensis*	Kthphoda	Picidae/VC
22	Yellow froned pied woodpecker	*Picoides manrattensis*	Kthphoda	Picidae/VC
23	Heart spotted woodpecker	*Hermicircu sconente*	Kthphoda	Picidae/VC
24	Blue rock pigeon	*Columba livia*	Kabutar	Collumbidae*/VC
25	Black winged kite	*Elanus caeruleus*	Kapasi	Accipitridae/VC
26	Large cuckoo	*Coradina novacholladiae*	Kasaya	Campeghagidae
27	Kestreel	*Falcotinnunculus*	Korutiya	Accipitridae
28	Koel	*Eudynamys scolopaceae*	Koyal	Cuculidae/VC
29	Black capped kingfisher	*Haleyan Pileata*	Korila	Alcedinidae
30	House crow	*Corvus splendens*	Kaua	Covidae/VC
31	Pied bushchat	*Saxicola caprata*	Kala pidda	Turdinae
32	Black partridge	*Francolinus francolinus*	Kala titar	Phasiamidae
33	Brown partridge	*Francolinus pictus*	Bhura titar	Phasiamidae
34	White eyed pochard	*Arthya nyrola*	Kurachia	Anatidae
35	Commonteal	*Anus crecea*	Kera	Anatidae
36	Rufaus backer shrike	*Lanius schach*	Kagla latora	Lamidae*/VC
37	Moorhen	*Pirphyrio parphyrio*	Kalim	Rallidae/VC
38	Indian robin	*Saxicolides falicata*	Kalchuri	Turdinae/VC

Table 1: Continued…

S.No	English name	Scientific name	Local name	Family/ Class
39	Mahalot	*Dendrocitta vagabunda*	Mahalat	Covidae
40	Coucal	*Centropus sinensis*	Mokha	Cuculidae/VC
41	Common pea fowl	*Pavo cristatus*	Mor	Phasiamidae/VC
42	Common myna	*Acridotheres tristis*	Myna	Sturnidae/VC
43	Pied kingfisher	*Ceryle rudis*	Kilkila	Alcenididae
44	White breasted kingfisher	*Halcyon smyrnensis*	Kilkila	Alcenididae
45	Little egret	*Egretta garzetta*	Kilchia	Ardeidae/VC
46	Pheasant tailed jacana	*Hydrophasianus chirurgus*	Pihua	Jacanidae
47	Yellow wagtail	*Motacilla glava*	Pilakh	Motacillidae
48	Grey wagtail	*Motacilla capica*		Motacillidae
49	Pied crested cuckoo	*Clamator jacobinus*	Papiha/Chatak	Cuculidae
50	Gray headed myna	*Sturunus malabaricus*	Pavai	Sturnidae
51	Green bee eater	*Merops orientalis*	Patringa	Meropidae/VC
52	Crested bunbing	*Melophus lathami*	Pathar chitra	Emberizidae
53	Little cormorant	*Phalcrocora xnizer*	Pankaua	Phalacrocoracidae
54	Shoveller	*Anus clypeata*	Panao tilari	Anatidae
55	Large Indian parakeet	*Psittacula eupatria*	Ram tota	Psittacidae/VC
56	Grey lit	*Parus major*	Ram gangara	Paridae
57	Yellow checked lit	*Parus xanthogenys*	Ram gangara	Paridae
58	King vulture	*Torgas calvus*	Rajgighha	Accipitridae
59	Purple sun bird	*Nectarinia asiatica*	Shakar khora	Nectarinidae
60	Tickell's blue flycatcher	*Muscicapatickel ling*	Shama	Muscicapidae
61	Shama	*Copsychus malabaricus*	Shama	Muscicapidae
62	Blue headed rock thrust	*Monticola cinclorhynchus*	Shama	Muscicapidae
63	White throated ground thrust	*Zoothera citrina*	Shama	Muscicapidae
	Crested hawk eagle	*Spizaetus cirrhatus*	Shahbaj	Accipitridae
64	Iora	*Aegithina tiphia*	Shanbiji	Irenidae
65	Lesser whistling teal	*Dendrocygna javanica*	Silhi	Anatidae
66	Sarus crane	*Grus antigone*	Sarus	Cruidae
67	Slaty headed scimitar bulbular	*Pomatorhinus schisticeps*	Sat bahan	Muscicapidae
68	Jungal babblar	*Turdoides striatus*	Sat bhai	Muscicapidae
69	Quaker babblar	*Alcippe poioicephale*	Sat bhai	Muscicapidae
70	Brahmini duck	*Tadorna ferruginea*	Surkhab	Anatidae
71	Red shank	*Tringa totanus*	Surma	Charadridae
72	Black ibis	*Pseudibis papillosa*	Kala buja	Threskiornithidae*
73	White scavenger vulture	*Neophron perencoprerus*	Safed giddh	Accipitridae
74	Grey partridge	*Francolinus pondicerianus*	Safed titar	Phasiamidae
75	Paradise flycatcher	*Terpsiphone paradisi*	Sun bulbul dudhraj	Muscicapidae
76	Black napped blue flycatcher	*Monarcha azurea azurea*	Sun bulbul dudhraj	Muscicapidae
77	Crested serpent eagle	*Spilornis cheela*	Dogracheel	Accipitridae*/VC
78	Owl	*Bubo bubo*	Ullu	Strigidae/VC
79	Painted stork	*Ibis leucocephalus*	Janghil/Dokh	Ciconidas
80	Red spur fowl	*Galloperdix spondica*	Jangli murgi	Phasiamidae

Table 1: Continued…

S.No	English name	Scientific name	Local name	Family/ Class
81	Crimsonbreasted barbot coppersmith	*Negalaima haemacephla*	Chhota basantha	Capitonidae
82	Estern golden plover	*Pluvialis dominica*	Chhota batan	Charadridae
83	Comman king fisher	*Alcedo atthis*	Chhota kilkila	Alcedinidae/VC
84	Tufted duck	*Anthya fukugula*	Dubaru	Anatidae
85	Magpie robin	*Copsychus saularis*	Daiya	Muscicapidae*/VC
86	White spotted flycatcher	*Rhipidura albicolis*	Chakdil	Muscicapidae
87	White browed fentail flycatcher	*Rhipidura aureola*	Chakdil	Muscicapidae
88	Fontail snipe	*Capelle gelliango*	Chaha	Charadridae
89	Common pariah kite	*Milvus migrans*	Cheel	Accipitridae/VC
90	Common hornbill	*Tocus birostris*	Chalotra	Bucerotidae
91	Ashy wren warbler	*Prinia socialis*	Futki	Muscicapidae
92	Tickellus flower peaker	*Dicaeum erythrarthynchas*	Fulchuki	Dicaedae
93	Fire breasted flower peaker	*Dicaeum ignipectus*	Fulchuki	Dicaedae
94	Rose ringed parakeet	*Psittacula krameri*	Tota	Psittacidae
95	Indian whiskered tern	*Childonias hybrida*	Tehri kurri	Laridae
96	Ashy shallow shrike	*Artamus fusus*	Tagaria babil	Diccuidae
97	Red Jungle fowl	*Gallus gallus*	Jangli murgi	Phasiamidae
98	Jangle crow	*Corvus macrorhynchus*	Jangli kaua	Corvidae/VC
99	Jangle myna	*Acridotheres fuscus*	Jangli mayna	Sturnidae/VC
100	Spotted owlet	*Athena brama*	Jangli chaughad	Strgidae*/VC
101.	Purpie moorhen	*Gallinula chloropus*	Jal murgi	Rallidae/VC
102.	Nukta ducker comb duck	*Sarkidiornis melanoros*	Nakta	Anatidae
103	Black headed munia	*Lonchura malacca*	Nakal nar	Ploceidae/VC
104	Indian roller blue joy	*Coracias benghalensis*	Nilkanth	Coracidae/VC
105	Indian pitta	*Pitta brachyura*	Navrang	Pittiadae/VC
106	Paddy bird pond heron	*Ardeola grayii*	Andha bagla	Ardeidae*/VC
107	Grey heron	*Ardea cinerea*	Anjan	Ardeidae
108	Pied starling	*Sturnus contra*	black myna	Sturnidae*/VC
109	Rufus tailed finch lark	*Ammomanes phocnicurus*	Aagiya	Alaudidae
110	Tawny eagle	*Aquila refax*	Okab	Accipitridae
111	Painted snipe	*Rostratula benghalensis*	Ohadra	Rostratuliridae
112	Blossom headed parakeet	*Psittacula cynocephala*	Tuiya tota	Psittacidae/VC
113	Cattle egret	*Bubulcus ibis*	Gay bagla	Ardeidae*/VC
114	Open bull stork	*Anostomus oscitans*	Godhila	Ciconidae
115	House sparrow	*Passer domestica*	Goraiya	Ploeidae/VC
116	Cottontail	*Nettapus coromon delianus*	Gurguri pandubbi	Anatidae
117	Black winged stilts	*Himantospus himantopus*	Gajpin	Recurvirostidae
118	White neck stork	*Ciconia episcopus*	Galgal	Ciconidae
119	White stork	*Ciconia ciconia*	Galgal	Ciconidae
120	Jangle bush quail	*Perdicula asiatica*	Lawa	Phasiamidae/VC
121	Red crested pochard	*Netta rufina*	Losir	Anatidae
122	Red mania	*Estrilda amandava*	Lal munia	Ploeidae/VC
123	Indian Clift swallow	*Hirundo fluvicola*	Lesra	Hirumdidae
124	Wire tailed swallow	*Hirundo smithii*	Lesra	Hirumdidae

Asian pied starling (*Sturnus contra*)

Spotted owlet (*Athene brama*)

Black ibis (*Pseudibis papillosa*)*

Blue Rock pigeon (*Columba livia*)*

Megpai robin (*Copsychus saularis*)*

Rufous backed shrike (*Lanius schach*)*

Red wattled lapwing (*Venellus indicus)**

Cattle egret (*Bubulcus ibis)**

????

Pond heron *(Ardeola grayii)**

Painted serpent eagle (*Spilornis cheel*)*

Table 2: Number of birds belonging to Order/Family

S. No.	Order	Family	No. of Birds
1	Charadriiformes	Jacanidae	1
		Rostratulidae	1
		Charadriidae	3
		Recurvirostridae	1
		Burhinidae	1
		Laridae	1 (8)
2	Columbiformes	Columbidae	2 (2)
3	Psittaciformes	Psittacidae	2 (2)
4	Ciconiiformes	Ciconidae	4
		Ardeidae	5
		Threskiornithidae	1 (10)
5	Anseriformes	Anatidae	9 (9)
6	Falconiformes	Accipitridae	8 (8)
7	Galliformes	Phasianidae	8 (8)
8	Gruiformes	Rallidae	2 (2)
9	Cuculiformes	Cuculidae	3 (3)
10	Passeriformes	Hirundinidae	2
		Alaudidae	1
		Motacillidae	4
		Campephagidae	2
		Pycnonotidae	1
		Irenidae	1
		Laniidae	1
		Sturnidae	5
		Corvidae	3
		Dicruridae	1
		Plocedae	4
		Emberizidae	1
		Nectarinidae	1
		Paridae	2
		Muscicapidae	13
		Turdinae,	3 (45)
11	Piciformes	Capitonidae	1
		Picidae,	3
		Sittidae, Pittidae	2+1 (7)
12	Coraciiformes	Meropidae	3
		Coracidae	1
		Alcedinidae	4
		Bucerotidae	2 (10)
13	Strigiformes	Strigidae	2 (2)
14	Dicaedae	Dicaedae	3 (3)
15	Gruiformes	Gruidae	2 (2)
16	Phalacaniformes	Phalcrocoracidae	1 (1)
17	Apodiformes	Apodidae	2 (2)

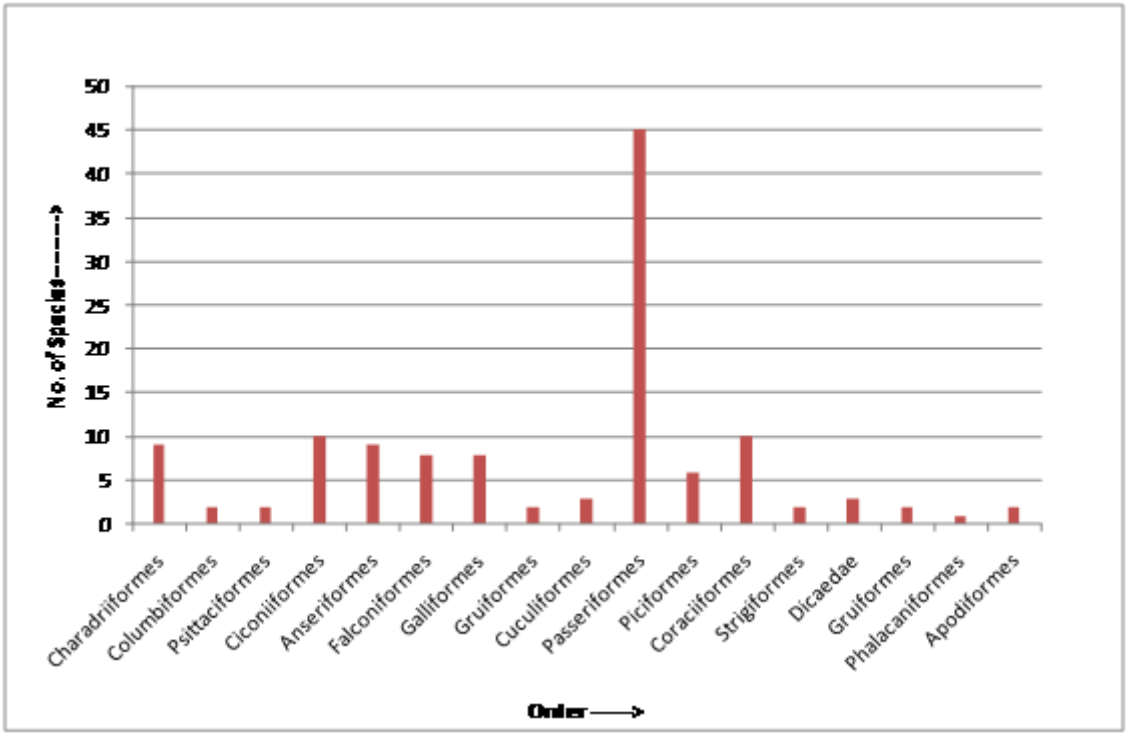

Fig. 1: Order wise bird diversity in West Division of Chhindwara M. P., India

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RESEARCH ARTICLE

Avifaunal Diversity of Malguzari Lake at Zaliya near Amgaon in Gondia district (M.S.) India

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ABSTRACT

The Malguzari Lake is located at Zaliya having rich aquatic vegetation and harbors several kinds of birds. The present study deals with the avifaunal diversity of Malguzari Lake at Zaliya near Amgaon in Gondia district of Maharashtra. The survey was conducted twice in a month from October 2014 to May 2015 during the day time depending on the light conditions. The twenty seven species were recorded belonging to 08 different orders and 11 families during the study period. Out of 27 recorded species, 13 were residents, 10 were resident migrants and 04 were migrants. The abundance status also recorded, maximum species were sighted during the winter season followed by summer season.

Keywords: Avifauna, diversity, Malguzari lake, status.

INTRODUCTION

Birds are often common denizen of the ecosystems and they have been considered as an indicator species of inhabited areas (Blair, 1999). Birds are excellent model organisms for understanding key issues in ecology, animal behaviour, evolutionary biology and conservation (Urfi, 2011). Birds, nearly everyone enjoys the beauty of their forms and coloring, the vivacity of their movement, the buoyancy of their flight and sweetness of their songs.

Birds which are ecologically dependent on wetlands are known as waterbirds. They play a significant role in human lives culturally, socially, scientifically and as a food resource (Kumar *et al.* 2003). Waterbirds are important components of most of the wetland ecosystems as they occupy several trophic levels in the food web of wetland nutrient cycles (Rajashekara and

Venkatesha, 2010). Freshwater lakes one of the important types of wetlands, play a vital role in the economics of their respective regions, especially with reference to agriculture, fishing, livestock maintenance and drinking water facilities of the adjacent areas.

The geographic location of a wetland may determine how and when birds will use it or use adjacent habitat (Manikannan, 2011). The shallow open water and marshy area supports a variety of aquatic and semi aquatic vegetation that provides an adequate food spectrum and good habitation for the living of the wetland birds (Arya *et al.* 2014). The density of avifauna at Navegaon National Park, Maharashtra was found to be maximum in winter as the count increased because of the arrival of winter migrants. Grazing of cattle is one of the reasons for the damage caused to the feeding and breeding grounds of the birds at Navegaon National Park, Maharashtra (Chinchkhede and Kedar, 2013). Local people used the wetlands for various purposes for their livelihood, fishing being most common activity. Anthropogenic factors cause the degradation of wetland ecosystem which leads to the destruction of habitat of waterbirds (Manakadan *et al.* 2011).

The waterbirds of Malguzari lake at Zaliya in Gondia district are important bioindicators of lake ecosystems which should be protected to conserve the biodiversity and environment. The present study is not carried out for only to prepare the checklist of birds, but to find out their occurrence and to create the awareness for their conservation. Therefore this work has undertaken to document the avifaunal diversity of Malguzari lake located at Zaliya near Amgaon town in the central region of India.

MATERIAL AND METHODS

Study Area

The Malguzari lake is located at Zalia (21°21'32.7" N and 80°25'31.2"E), 6.1 km away from Amgaon town in Gondia district, Maharashtra State, India (https://www.google.co.in/maps/place/Zaliya,+Maharashtra).

The Malguzari lake is the principal local freshwater body and the area of this lake is spread over 50 acre. The lake has rich potential of flora and fauna. The population of Zaliya is 1691 as per census 2011, and the water of this lake is primarily used for washing, bathing, fishing activities and for irrigation purposes.

Survey of the site

The study was conducted during October 2014 to May 2015 aims to examine the avifauna from study area. The observation of the birds was carried out by using field binocular (10×50 magnification) depending on the light conditions during the day time (Namgail *et al.* 2009). The bird population was estimated by direct count method twice in a month as described and employed by (Bibby *et al.* 2000; Urfi *et al.* 2005). After detection, specimen was photographed by camera and identified with the help of keys and methods suggested by Ali (2002), Grimmett *et al*. (2011) and Manakadan *et al.* (2011).

RESULTS AND DISCUSSION

During the present investigation, 27 species of birds were recorded belonging to 08 orders and 11 families. Among the recorded species of birds, 01 species belongs to orders podicipediformes and coraciiformes each, 02 species belongs to pelecaniformes, charadriiformes and Passeri formes each, 03 species belongs to gruiformes, 07 species belongs to anseriformes, and 09 species belongs to ciconiiformes order.

Among the recorded species of birds, 01 species belongs to families podicipedidae, jacanidae, charadriidae and coraciidae each, 02 species belongs to families phalacrocoracidae, ciconiidae, threskiornithidae and sturnidae each, 03 species belongs to family rallidae, 05 species belongs to ardeidae family, 07 species belongs to anatidae

Table 1: List of Bird species of Malguzari Lake at Zaliya

Sr. No.	Scientific Names	Common Names	Residential Status	Abundance Status
Order 1: Podicipediformes				
Family 1: Podicipedidae				
1	Tachybaptus ruficollis	Little Grebe	R	C
Order 2: Pelecaniformes				
Family 2: Phalacrocoracidae				
2	Phalacrocorax fuscicollis	Indian Shag (Indian Cormorant)	RM	U
3	Phalacrocorax niger	Little Cormorant	RM	C
Order 3: Ciconiiformes				
Family 3: Ardeidae				
4	Casmerodius albus	Large Egret (Great Egret)	RM	U
5	Mesophoyx intermedia	Median Egret (Intermediate Egret)	RM	U
6	Egretta garzetta	Little Egret	RM	C
7	Bubulcus ibis	Cattle Egret	RM	C
8	Ardeola grayii	Indian Pond Heron	R	C
Family 4: Ciconiidae				
9	Mycteria leucocephala	Painted Stork	RM	U
10	Anastomus oscitans	Asian Openbill Stork	R	U
Family 5: Threskiornithidae				
11	Pseudibis papillosa	Red-naped Ibis (Black Ibis)	R	U
12	Threskiornis melanocephalus	Oriental-white Ibis (Black-headed Ibis)	R	U
Order 4: Anseriformes				
Family 6: Anatidae				
13	Tadorna ferruginea	Ruddy Shelduck (Brahminy Shelduck)	RM	U
14	Dendrocygna javanica	Lesser Whistling Duck	R	U
15	Anas acuta	Northern Pintail	M	C
16	Anas crecca	Common Teal	M	C
17	Aythya ferina	Common Pochard	M	Ra
18	Netta rufina	Red-crested Pochard	M	A
19	Nettapus coromandelianus	Cotton Pygmy-Goose (Cotton Teal)	R	A
Order 5: Gruiformes				
Family 7: Rallidae				
20	Gallinula chloropus	Common Moorhen	RM	C
21	Fulica atra	Common Coot (Eurasian Coot)	RM	A
22	Porphyrio porphyrio	Purple Swamphen	R	C
Order 6: Charadriiformes				
Family 8: Jacanidae				
23	Metopidius indicus	Bronze-winged Jacana	R	Ra
Family 9: Charadriidae				
24	Vanellus indicus	Red-wattled Lapwing	R	C
Order 7: Coraciiformes				
Family 10: Coraciidae				
25	Coracias benghalensis	Indian Roller	R	C
Order 8: Passeriformes				
Family 11: Sturnidae				
26	Gracupica contra	Asian Pied Starling	R	C
27	Acridotheres tristis	Common Myna	R	C

Residential Status: R - Resident, RM - Resident Migrant, M - Migrant
Abundance Status: A - Abundant, C - Common, U - Uncommon, Ra – Rare

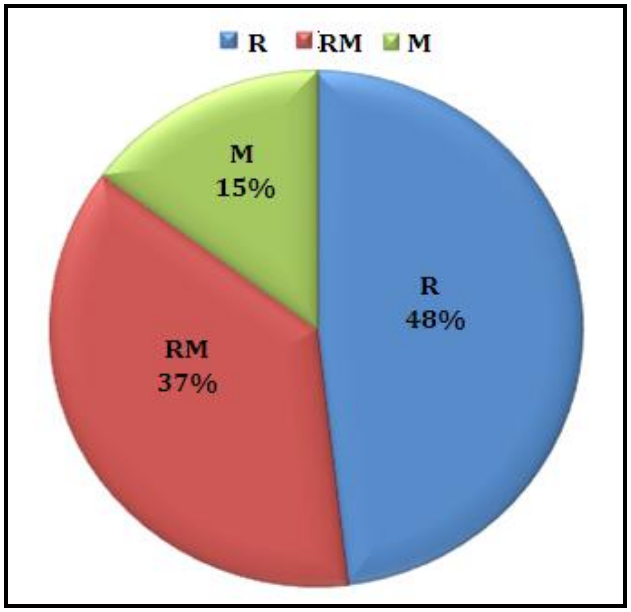

Fig. 1: Residential status of Bird species

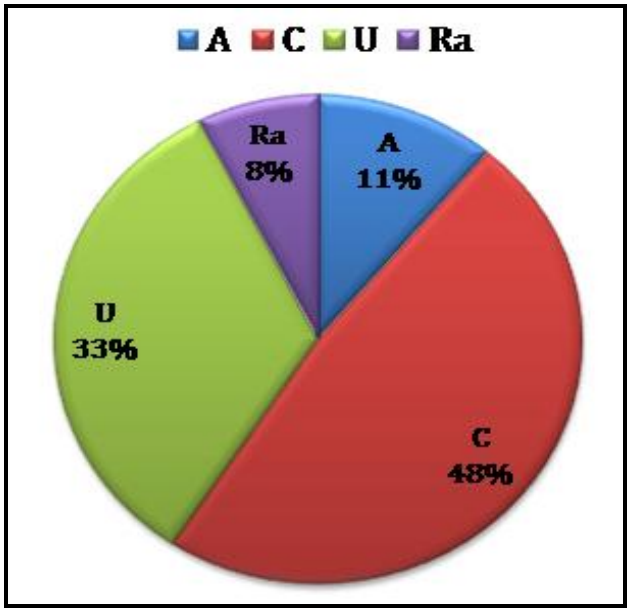

Fig. 2: Abundance status of Bird species

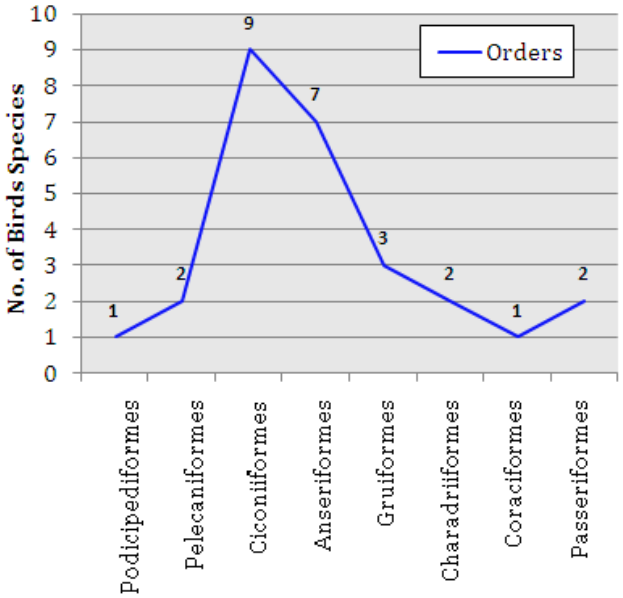

Fig. 3: Order wise status of Bird species

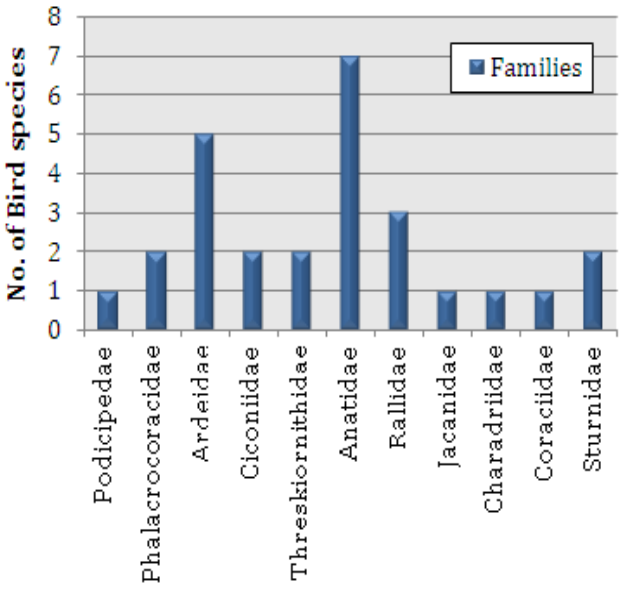

Fig.. 4: Family wise status of Bird species

Fig. 5: A view of Malguzari Lake at Zaliya

Fig. 6: Common Coot (Eurasian Coot)

Fig. 7: Little Cormorant

Fig. 8: Purple Swamphen

Fig. 9: Red-crested Pochard

family. Out of 27 species, 13 were residents (48%), 10 were resident migrants (37%) and 04 were migratory (15%) bird species. The abundance status also recorded, out of 27 species, 11% were abundant, 48% common, 33% uncommon and 08% were rare species. The maximum species were recorded during winter season followed by summer.

Many researchers from Maharashtra such as Yardi *et al.* (2004) reported 64 species from Salim Ali lake Aurangabad, Pawar *et al.* (2005) reported 74 species in and around Yedshi lake Mangrulpir of Washim district, Kulkarni *et al.* (2005) reported 151 species in and around Nanded city, Kasambe and Wadatkar (2007) recorded 78 species from Pohara-Malkhed forest reservoir of Amravati district, Kedar *et al.* (2008) recorded 74 species from two freshwater lakes of Washim district. Kanwate and Jadhao (2010) recorded 10 species in Bhokar tahsil of Nanded district, Kulkarni and Kanwate (2010) reported 62 species from Jaldhara forest of Kinwat of Nanded district, Kukade *et al.* (2011) recorded 68 species from Chhatri lake of Amravati district, Hippargi *et al.* (2012) reported 65 species in a highly fragmented grassland patch near Solapur, Joshi (2012) reported 28 species from Rajura, Godada and Dhanora lakes of Buldhana district, Harney (2014) reported 55 species around the Ghotnimbala lake near Bhadrawati as well as 37 species from Kanhala pond Harney *et al*. (2013) with preference to feeding habits of Bhadrawati in Chandrapur district. Bhandarkar and Paliwal (2014) reported total 52 water birds species from Shrungarbandh Lake, Gondia District.

CONCLUSION

Avifaunal diversity of the Malguzari lake at Zaliya confirm the lake as suitable habitat for the residential and some migratory birds. But the birds present in and around the lake are affected by anthropogenic disturbances like washing clothes, direct bathing in lake, washing livestocks, immersing of idols, fishing practices and pollution due to spraying of insecticides on rice crop in nearby area. Yet the avifauna of the Malguzari lake at Zaliya is diverse; keeping in view the varied avifauna recorded, steps should be taken to do proper maintenance and conservation of the lake.

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https://www.google.co.in/maps/place/Zaliya,+Maharashtra

RESEARCH ARTICLE

Seed germination performance in *Trigonella foenum-graecum* L. under the influence of Gibberellic acid, Oxygenated Peptone and Vermiwash

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ABSTRACT

Oxygenated peptones and Vermiwash are commonly used in organic farming practices. In the present investigation, experiments were carried out to study the influence of Gibberellic acid (50 ppm), Oxygenated peptone (1% aqueous) and Vermiwash (20%) on fenugreek (*Trigonella foenum-graecum* L.) var. early bunching during seed germination by using petri-plate method. Distilled water was considered as control. Oxygenated peptone and Vermiwash showed promontory effect on germination percentage. All three treatments stimulated vigour index and also showed enhancement in fresh and dry weights of root and shoot. Oxygenated peptone and Vermiwash showed supremacy in root length while GA treatment remarkably enhanced shoot length. Oxygenated peptone, Vermiwash and GA treatments showed significant improvement in the amount of total carbohydrates, soluble proteins and activities of enzymes like amylase, protease and catalase. The study revealed that Vermiwash, Oxygenated peptone and GA improve the process of germination with positive alteration in biochemical aspects.

Keywords: Organic farming, Oxygenated peptone, Vermiwash, Gibberellic acid.

INTRODUCTION

In the modern era of agriculture, organic farming is an urgent need to reclaim deteriorated agricultural land for sustainable agriculture. Organic farming is productive systems which take

care of soil and rely in use of organic fertilizers, crop rotation, biocontrol, phytoremediation, vermintechnology and biofertlizers while strongly deny synthetic agrochemicals, plant growth regulators and genetically modified organisms. Werner (1997) and Tester (1999) suggested organic fertility inputs, such as composted farm yard and green manure, improve the soil physical properties by lowering bulk density, increasing water-holding capacity and improving infiltration rates. Organic farming systems are more sustain- able than conventional agricultural techniques and represent commerce-ally viable alternative (Marangoni *et al.,*2004). Pretty *et al.*,2002), observed that implementation of organic farming in some developing countries causes higher yield of production. Among many benefits of organic farming, the most obvious advantage that might mostly be considered for small-scale farmers is their traditional knowledge of natural environ- ment can be well matched with organic farming (Closter *et. al.* 2004).

Earthworms play significant roles in agro-ecosys-tems. Their feeding and burrowing activities incor-rporate organic residues and amendments into soil, enhancing decomposition, humus formation, nutrient cycling and soil structural development (Mackay & Kladivko,1985; Kladivko *et al.,*1986). Vermicompost and Vermiwash are crucially important in organic farming. Vermicompost are typically finely divided peat like materials with high porocity, moisture content, aeration and water holding capacity (Edwards and Burrows, 1988). Vermiwash is a liquid manure obtained from earthworms while vermicompost prepara-tion. Apart from nitrogen, potash, phosphourus, other micronutrients it also contains phytohor-mones like auxins and cytokinins. Vermiwash contain nitrogen fixing bacteria such as Azotoba-cter sp., Agrobacterium sp., and Rhizobium sp. and also enzyme cocktail of proteases, amylases, urease and phosphatase (Zambare *et. al.*, 2008). Oxygenated peptone is organic, creamy white powder. It consists of 100 mg/g oxygen, 650 mg/g peptone & 250 mg/g inert filler compound. It is a source of soluble nitrogen as well as oxygen. Organic substance like oxygenated peptone can be successfully used for soil conditioning under organic farming (Patil *et. al.,* 2008; Thakare *et. al*., 2011; Jagtap, 2012).

Fenugreek (*Trigonella foenum-graecum* L.), a member of Fabaceae is an annual herb with trifoliate leaves, cultivated worldwide as leafy vegetable, spice, forage and medicinally potential crop. It is extensively cultivated in most regions of the world for its medicinal value (Petropoulos, 2002). Fenugreek seeds are good source of prot ein, fat, minerals and dietary fiber (Kochar *et al.*, 2006). Seeds are used in colic, flatulence, dysen-tery, diarrhea, dyspepsia with loss of appetite, diarrhea in puerperal women, chronic cough, dropsy, and enlargement of the liver and spleen (Nadkarni, 2005). The seed extracts normalize the enhanced lipid peroxidation and relieve oxid-etive stress by providing antioxidants in diabetic rats (Anuradhaand Ravikumar, 2001). The notab-le chemical constituents of fenugreek are proteins that are rich in lysine and tryptophan, flavonoids such as quercetin, trigonelline, saponin, phytic acid and polyphenols (Billaudand Adrian, 2001).

Germination is resumption of plant life from seed. The phenomenon is preceded by the absorption of water by the dry seeds followed by degrada-tion and mobilization of reserves accumulated during seed formation and maturation. Germina-tion percentage, speed of germination and germination performance at morphological and biochemical level greatly determines the yield of crop. Oxygen supply is most critical and funda-mental requirement for growth, productivity of plants and the rate of germination increases with oxygen supply (Taiz and Zeiger, 2002). To encourage organic farming, attempts were made to study the effect Vermiwash, Oxygenated peptone and Gibberellic acid on fenugreek during germination of seeds.

MATERIALS AND METHODS

Eudrilus eugineae (Fig.1 and Fig. 2). a species of earthworm was cultured for the preparation

vermiwash Large plastic container with a tap attached at the bottom was used for vermiwash draining. At the bottom of container a base layer of gravel was made which then covered by a layer of 4-5 cm thick layer of coarse sand. Partially decomposed compost with leaf litter was placed on the top of sand and earthworms were introduced. Moisture level was maintained by sprinkling water once in 2 or 3 days as per need. Vermiwash was collected after 10 day.

Fig. 1:

Fig. 2:

Seeds of fenugreek (*Trigonella foenum-graecum* L. var. early bunching) were surface sterilized with 0.05 % HgCl2 for minute and rinsed thoroughly with tap water and then with distilled water. The surface sterilized seeds were arranged in petri plates (10 seeds/plate) containing germination paper. 10 ml of distilled water (control), 20% Vermiwash, 1% aqueous Oxygenated peptone and 50 ppm Gibberellic acid was poured in the respective petri-dishes. Numbers of seeds germinated were recorded daily. Germination parameters like germination percentage, shoot length, root length, shoot/root ratio, fresh weight and dry weight were studied on 6 DAS using routine method. Vigour Index (VI) was calculated according to the method suggested by Baki and Anderson (1993). Biochemical constituents were analyzed on 8 DAS using methods proposed by Lowry *et. al.* (1951) for soluble proteins and Sadasivam and Manickam (2005) for total carbohydrates. The enzyme activity was studied on 10 DAS. The enzyme activity of Amylase (E.C. 3.2.1.1) and Catalase (E.C. 1.11.1.6) was scored by the methods of Sadasivam and Manickam and that of Protease (E.C. 3.4.2.2) by the method of Penner and Ashton (1967).

RESULTS AND DISCUSSION

The treatment of GA, Vermiwash and Oxygenated peptone showed enhancing effect on morphological parameters of germinating seeds of fenugreek. Table 1 exhibit the effect GA and vermiwash and oxygenated peptone on morphological parameters of germinating seeds of fenugreek 6 days after sowing (DAS). Seeds showed 98 % germination under Oxygenated peptone treatment and control (distilled water) while 100 % under GA and vermiwash treatments. Vermiwash contain higher amount of potassium (K) than sodium (Na) (Shlrene *et. al.*2012). Potassium, as one of the essential macro-nutrients, is needed in higher amount for better plant growth (Bumb and Hammond, 2005). Patil, *et. al.* (2008) reported enhancing effect of Oxygenated peptone during germination processes in Solanaceous fruit vegetables like tomato, brinjal and chilli by seed priming treatment. The effect of GA on stem elongation and leaf enlargement is well known. Riley J. M. (1987) stated that GA plays direct role in stem elongation. All three treatments promoted morphological parameters like shoot length, root length, fresh and dry weights of stem and root. GA (25.61%) showed supremacy over Vermiwash (14.03%) and Oxygenated peptone (9.29%) for shoot elongation, while Vermiwash (51.63%) and Oxygenated peptone (29.79%) showed upper hand on root elongation than control and GA

(12.24%). Cherif *et. al.* (1997) were advocated that oxygenated peptone supports the development of root system than that of shoot system during germination by supplying soluble nitrogen and oxygen so that seedling is established with extended root system. Due to elongation of shoot, shoot/root ratio was positively improved by GA (18.10%), while Vermiwash (-25%) and Oxygenated peptone (-16.37%) exhibited negative values because of root elongation. All treatments showed increasing effect on fresh as well as dry weights of shoot and root. GA showed upper hand in fresh weight of shoot (40%) than Vermiwash (30.05%) and Oxygenated peptone (29.18%). Dry weight of shoot was improver more by Vermiwash (60.71%) and Oxygenated peptone (44.04%) than GA (17.85%).

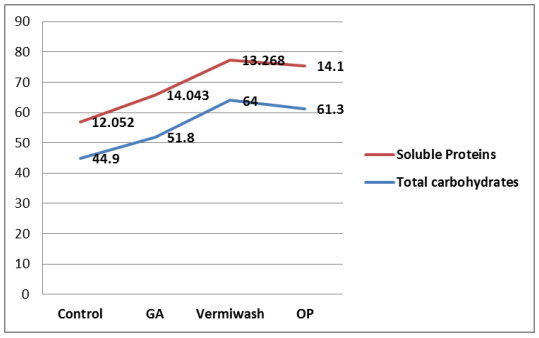

Fig. 3. Biochemical constituents

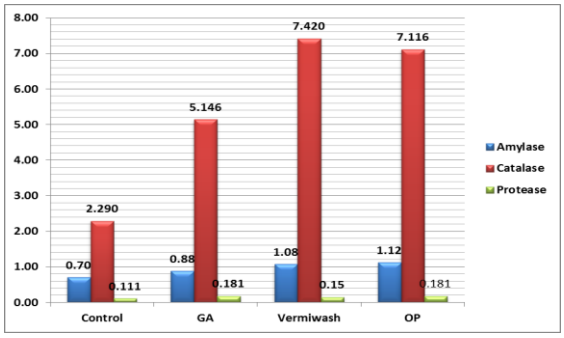

Fig. 4. Enzyme activity

Table 1. Effect of GA,Vermiwash and Oxygenated peptone on seeds of Fenugreek (*Trigonella foenum-graecum* L. var. early bunching) on morphological parameters of seedlings (6 DAS).

Parameters	Control	Treatments					
	Distilled water	Gibberellic acid	Increase (%)	Vermiwash	Increase (%)	Oxygenated peptone	Increase (%)
Germination percentage	98	100	2.00	100	2.00	98	--
Shoot length (cm)	5.70 ± 0.31	7.16 ± 0.15	25.61	6.50 ± 0.54	14.03	6.23 ± 0.15	9.29
Root length (cm)	4.90 ± 0.54	5.20 ± 0.62	12.24	7.43 ± 0.55	51.63	6.36 ± 0.48	29.79
Shoot/Root Ratio	1.16 ± 0.17	1.37 ± 0.15	18.10	0.87 ± 0.01	-25.00	0.97 ± 0.01	-16.37
Shoot : Fresh wt. (g)	0.915 ± 0.075	1.281 ± 0.044	40.00	1.190 ± 0.006	30.05	1.182 ± 0.075	29.18
Root : Fresh wt. (g)	0.320 ± 0.006	0.387 ± 0.005	20.93	0.458 ± 0.006	43.12	0.438 ± 0.006	36.87
Shoot : Dry wt. (g)	0.084 ± 0.002	0.099 ± 0.007	17.85	0.135 ± 0.003	60.71	0.121 ± 0.006	44.04
Root : Dry wt. (g)	0.021 ± 0.006	0.024 ± 0.002	14.28	0.031 ± 0.003	47.61	0.030 ± 0.003	42.85
Vigour Index (VI)	1038.8 ± 27.07	1236 ± 35.01	21.58	1393 ± 20.65	34.09	1233.8 ± 20.01	18.77

♣ Each value is measure of mean±SD of triplicate.

Table 2. Effect of GA,Vermiwash and Oxygenated peptone on seeds of Fenugreek (*Trigonella foenum-graecum* L. var. early bunching) on biochemical constituents (8 DAS) and enzyme activity (10 DAS).

Parameters	Control	Treatments					
	Distilled water	Gibberellic acid	Increase (%)	Vermiwash	Increase (%)	Oxygenated peptone	Increase (%)
Biochemical constituents							
Total carbohydrates (mg/g FW)	44.9 ± 6.90	51.8 ± 2.85	15.23	64.00 ± 3.85	42.53	61.3 ± 2.46	36.52
Soluble Proteins (mg/g FW)	12.052 ± 0.21	14.043 ± 0.25	16.52	13.268 ± 0.20	10.08	14.100 ± 0.21	16.99
Enzyme activity							
Amylase (mg maltose/ 5min/g FW)	0.70 ± 0.012	0.88 ± 0.008	25.71	1.08 ± 0.016	54.28	1.12 ± 0.035	60.00
Catalase (µ mole H_2O_2/ min/g FW)	2.290 ± 0.021	5.146 ± 0.022	124.71	7.042 ± 0.011	207.51	7.116 ± 0.060	210.74
Protease (µg tyrosine/ hr/mg protein)	0.112 ± 0.001	0.180 ± 0.002	60.71	0.15 ± 0.004	33.92	0.205 ± 0.015	83.03

♣ Each value is measure of mean±SD of triplicate.

Vermiwash and Oxygenated peptone exhibited superiority in fresh weight (43.12% and 36.87% respectively) and dry weight (47.61% and 42.85% respectively) of roots than GA (Fresh weight 20.93% and Dry weight 14.28%). Vigour Index (VI) is a product of root length, shoot length and germination percentage and determines the effect external agents on seed germination. There was significant increase in VI values under the treatment of Vermiwash (1393) and Oxygenated peptone (1233.8) than that of GA (1236) and control (1038.8).

The effect treatment of GA, Vermiwash and oxygenated peptone on biochemical constituents (Fig. 3) and enzyme activity (Fig. 4) on 8DAS and 10DAS of germinating seeds of fenugreek (*Trigonella foenum-graecum* L. var. early bunching) is exhibited in Table 2. All treatments showed remarkable increase in total carbohydrates and soluble protein contents. The ascending order for total carbohydrates was control (44.9 mg/gram fresh tissue) < GA (51.8 mg/gram fresh tissue) < Oxygenated peptone (61.3 mg/gram fresh tissue) < vermiwash (64.0 mg/gram fresh tissue). Thakare *et.al.* (2011), stated that oxygenated peptone provides soluble nitrogen along with oxygen, hence increase amount of soluble proteins significantly. The observed increasing order of soluble proteins content was, Control (12.052 mg/gram fresh tissue) < Vermiwash (13.268 mg/gram fresh tissue) < GA (14.043 mg/gram fresh tissue) < Oxygenated peptone (14.100 mg/gram fresh tissue).

In the investigation activity of enzymes like amylases, catalase and proteases increased under all treatments as compare to control. Thakare *et. al.* (2011) reported that pre-sowing treatment of

oxygenated peptone and GA improves physiological performance of chick pea seed during germination. Enzymes are activated with an accompanying mobilization of reserve material ending in transport of reserve material in the embryo in somatic conditioning and thus stronger seedlings are obtained as a result of embryo growth (Muhyaddin and Wiebe, 1989). Superoxide dismutase (SOD) and catalase (CAT) acts as scavengers of reactive oxygen species which are produced during environmental stresses like high/low temperature, water stress, air pollution, UV-light and chemicals. Sangeetha (2010), in fenugreek, reported SOD and CAT increases significantly under the influence of carbendazim. The activity of catalase was significantly higher under Oxygenated peptone treatment (7.116 µ mole H_2O_2/min/g FW) followed by Vermiwash (7.042 µ mole H_2O_2/min/g FW), GA (5.146 µ mole H_2O_2/min/g FW) and control (2.290 µ mole H_2O_2/min/g FW). Oxygenated peptone showed supremacy in activity of amylase and protease over Vermiwash, GA and control. The observed order for amylase was Oxygenated peptone (1.12 mg maltose/5min/g FW) > Vermiwash (1.08 mg maltose/5min/g FW) > GA (0.88 mg maltose/5min/g FW) > control (0.70 mg maltose/5min/g FW) and for protease, Oxygenated peptone (0.205 µg tyrosine/hr/mg protein) > GA (0.180 µg tyrosine/hr/mg protein) > Vermiwash (0.150 µg tyrosine/hr/mg protein) > control (0.112 µg tyrosine/hr/mg protein).

CONCLUSION

In the present investigation Vermiwash and Oxygenated peptone treatments showed supremacy in biochemical aspects such as total carbohydrates, soluble protein contents as well as enzyme activities over GA treatment and control which is significant. All treatments showed enhancing effect on morphological parameters like root length, shoot length, root dry and fresh weight, shoot fresh and dry weight, vigour index. Seed response during germination crucially determines crop productivity. GA is well known growth promoting phytohormone, it enters in the metabolic pathways and alters them and hence its use is denied in the practices of organic farming. On the contrary Vermiwash and Oxygenated peptone are biological in origin and provide eco-friendly environment for luxurious growth plants, improve health of soil and increase population of beneficial microbes, hence recommended for organic farming. To study the effect of Vermiwash and Oxygenated peptone on microbial population needs further investigation.

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RESEARCH ARTICLE

Anti-Microbial Activities of *Michelia champaca* L. Essential Oil

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ABSTRACT

The essential oils contain chemical components, which impart the anti microbial activity. Champa oil or Champaca oil extracted from the flowers of *Michelia champaca* L. is highly esteemed in preparation of attars and perfumed hair oils. The flower oil of *Michelia champaca* L. is used as an application in cephalagia, opthalmia, gout and rheumatism and fruits and seeds are considered useful for healing cracks in feet. Many essential oils have been explored but the essential oils in *Michelia champaca* L. have not been fully explored and researched in India and thus a very basic and practical study is required. The essential oil from *Michelia champaca* L. flowers was obtained using n-Hexane and the assay was carried out using freshly prepared *M. champaca* L. essential oil extract. The hexane extract of Champaca essential oil was prepared and screened for its anti-microbial activity. A slight inhibition was found against *Staphylococcus aureus,* a Gram-positive test organism by the susceptibility disc method. 25% inhibition was observed against *Staphylococcus aureus* by the Durham's diffusion tube assay indicating anti-microbial principles of lower potency in the champaca essential oil extract.

Ker Words: *Michelia champaca* , essential oil, n-Hexane, anti-microbial, *Staphylococcus aureus.*

INTRODUCTION

Most of the flower essential oils in addition to their antioxidant property also possess anti-bacterial and anti-fungal activity. *Artemesia annua* contains compounds such as camphor (41%), germacrene (16%), trans-pinocarveol (11%) which were found to possess inhibitory activity against Gram positive bacteria and

some Fungi (Juteau et al., 2002). Many plants have been exploited as a source of biologically active compounds. Over 25% of the biological preparations contain at least one component origination from plant sources. Plants possess anti microbial and anti oxidant components which are sometimes used to preserve food reserves in the world. Several research groups have tried to isolate and identify individual constituents present in the plant and to relate the chemical composition to the observed biological activity. The greatest antimicrobial activity of plants lies within 'Volatile oils' (Williams, 1996)

The essential oils of three *Micromeria* species such as *M. dalmatica, M. albanica* and *M. thymifolia* were analysed and the essential oils showed strong fungitoxicity. The essential oils also exerted anti bacterial effect against bacteria at low concentrations (Marinkovic *et al.*, 2003).

The essential oils contain chemical components, which impart the anti microbial activity. Compounds such as methyl pyrimidine, β-glucopyranosyl triene isolated from flowers of *Alangium* showed antibacterial activity against many gram positive and gram-negative organisms (Arjun *et al*, 2002).

Thymol issimple phenol, which is present in the essential oil several plants and has been used for its antiseptic activity. A major component of essential oils Cineol (Eucalyptol) which is found in many essential oils showed in vitro antimicrobial activity at an inhibitory concentration of 0.28 to 2.25 mg/ml. Camphor and its derivatives borneol, terpine 4-ol also can be considered to have anti microbial activity (Daferera, *et al*, 2003).

Geraniol and Eugenol are the chemical components found in many essential oils. The anti fungal activity of these compounds has been investigated by the well agar diffusion method and the compounds show considerable anti fungal activity. Thus the various activities of essential oils can be the property given them by their chemical components.

Michelia genus consists of trees and shrubs belonging to the family Magnoliaceae. *Michelia* genus consists of many species with flower and essential oil bearing plants. The different *Michelia* species have been exploited and considerable research has been done on the various parts of the plant such as the leaves, flowers, fruits, stem and the bark. *Michelia champaca* is a tall evergreen tree cultivated throughout India in gardens and near temples for its fragrant flowers and handsome foliage. Champa oil or Champaca oil extracted from the flowers of *M. champaca* is highly esteemed in preparation of attars and perfumed hair oils.

The flower oil of *Michelia champaca* is used as an application in cephalagia, opthalmia, gout and rheumatism and fruits and seeds are considered useful for healing cracks in feet (Khan et al, 2002).

There is great scope for the use of essential oils in various purposes. The reviwew of literature reveals that many essential oils have been explored but the essential oils in *Michelia champaca* have not been fully explored and researched in India and thus a very basic and practical study is required. The present studies are aimed at:

The qualitative analysis on the anti-microbial studies of the extracted essential oil by two methods:

1. Disc susceptibility method

Durham's fusion tube method (for volatile compounds).

MATERIAL AND METHODS

- The fresh Champaca flowers were collected in the months of September, October and November. The flowers were then air dried.
- The essential oils were extracted using the solvent extraction method (Guenther, 1972).
- For antimicrobial assays, Nutrient Agar Media was used for maintaining standard test microorganisms and sub-cultures.

- Mueller Hinton Agar was used for the actual disc susceptibility test.
- Nutrient broth and Tripticase Soya Broth (TSB) were used for preparation of the innoculum densities.
- All the medias were obtained from Hi Media Laboratories.
- Four test organisms were used for the anti microbial assays of the essential oil. The four test organisms included two Gram positive and two Gram negative strains. The standard cultures and their culture conditions have been listed in Table:

Table 1: Micro organisms used for present study and their culture conditions:

Microorganisms	Media	Type	Incubation Temp.
Escherichia coli ATC10148	Nutrient agar	Standard Isolate	37^0C
Pseudomonas aeruginosa	Nutrient agar	Clinical Isolate	37^0C
Staphylococcus aureus ATCC 25923	Nutrient agar	Standard Isolate	37^0C
Staphylococcus epidermis	Nutrient agar	Nutrient agar	37^0C

Note: *the standard cultures were obtained from C.B. Patel Research Centre, Vile Parle (W).the cultures were subcultured to maintain their purity and viability.*

Anti microbial assay:

Susceptibility Disc method: The anti microbial assay was carried out using susceptibility disc method (Jacques, 1980).

- Collection and maintenance of cultures: The standard cultures obtained from C.B.Patel Research Centre have been listed in table and were preserved at 4^0C in refrigerators after 24hr inoculation. The cultures were sub-cultured every week to maintain their purity and viability.

- Preparation of inoculum: Few of colonies were selected from the initial (Master) plates/slants and suspended in a small volume of saline (about 5 ml). the inoculums can also be prepared in TSB(Tripticase Soya Broth) or BIH (Brain Heart Infusion) medium.
  The inoculum was incubated for 1-2 hours and turbidity of culture was matched with that of '1' standard of Mc Farland opacity tubes. The turbidity was adjusted with the help of saline, TSB or BHI.
  Note- Mc Farland turbidity standard of '1' is equal to inoculum of $3x10^8$ *cells/ml*

- *Inoculation of Nutrient Agar Plate*: the entire surface of the plate was to be inoculated and therefore 0.1 ml of the adjusted culture was added to the surface of the plates with the help of sterile pipettes. A sterile cotton swab was rotated several times in several directions to dry the added inoculum on the plate and thus ensure even distribution and diffusion of the culture.

- *Preparation of Anti-microbial Discs*: In accordance to the FDA standards, sterile plain filter paper discs (Sterile Discs SD067) were purchased from HI Media Laboratories Pvt. Ltd. 20 µl of the Champaca essential oil extract was carefully added on the discs with the help of a sterile pipette. The discs were stored at -20^0C for 30 minutes and then used for inoculation. The same procedure was repeated for n-Hexane to check for its anti microbial activity.

- *Application of Discs*: 10 to 15 minutes after inoculation of plates the Champaca essential oil and n-Hexane discs were placed in center of each inoculated plate. The results were observed 18-24 hrs after the inoculation and incubation.

Durham's Diffusion Method:

The bioassay for volatile essential oils was carried out by Durham's diffusion method . The aromatic substances (essential oils) of natural origin are used medicinally in Ayurveda and can have diverse biodynamic actions. A novel method

to study the anti-microbial properties of volatile components of aromatic oils such as *Michelia champaca* is being used here. The existing methods might not be adequate an oil on to study an exclusive effect of the volatile components of an oil on microbes due to lack of lateral diffusion and evaporation from surface (Agnihotri and Vaidya, 1996).

- *Collection and Maintenance of Standard Test Cultures*: The same standard cultures as tabulated earlier were used for the anti-microbial assay Durham's diffusion assay.

- *Preparation of inoculums*: the same inoculums as used in the Disc Susceptibility Test i.e. Mc Farland's standard of '1' were used which corresponds to inoculum of $3x10^8$ cells/ml.

- *Inoculation of Nutrient Agar Slants:* Nutrient agar slants were inoculated by streaking a loopful of the prepared inoculum and incubating at 37^0C for 24 hrs.

- *Preparation of Durham's Tubes*: Autoclaved Durham's fusion tubes (2mm diameter) were picked up by sterile forceps and 0.1 ml of the Champaca essential oil extract was added to it. Control tubes with same quantity of n-Hexane are also filled and were used as a positive control. These tubes were then introduced in pre inoculated culture tubes (slants) with the help of sterile forceps. The tubes were then incubated in a tilted position (30 ^{0} angle) o let the emerging vapours from the essential oil extract and hexane act on the inoculated slants. The results were read after 24 hrs and the percentage of inhibition was recorded.

- *Interpretation of the Results*: The inhibition of bacterial growth was expressed in terms of the total slant expressed. Thus bacterial growth restricted only to the proximal end of the fusion tube and approximately covering 25% of the slant area was designated as single (+), similarly 50% inhibition of bacterial growth was represented by (++), 75% of the area under inhibition by (+++) and when there was 100% inhibition of bacterial growth it was shown by (++++). The results were recorded after incubation for 24 hours and changes in the growth pattern were noted down.

RESULTS AND DISCUSSION

The essential oil from *Michelia champaca* flowers was obtained using n-Hexane. The assay was carried out using freshly prepared *M. champaca* essential oil extract. The hexane extract of Champaca essential oil was prepared and screened for its anti microbial activity by Durham's diffusion method. The activity of the oil was tested against four standard organisms and the results were recorded after 24 hours. The results obtained from the primary qualitative screening of the essential oil are tabulated in table 2:

Table 2: Effect of Champaca essential oil extract and n-Hexane on the test organisms (Durham's diffusion method)

Microorganisms	Essential oil tube (24 hrs)	n-Hexane Control Tube (24 hrs)
Escherichia coli ATC10148	-	-
Pseudomonas aeruginosa	+	-
Staphylococcus aureus ATCC 25923	-	-
Staphylococcus epidermis	-	-

(+): 25% inhibition of organisms from proximal to distal end of the tube
(-): No inhibition of organism from proximal to distal end of tube.
24 hrs: Results read after 24 hours of inhibition.

Table 3: Effect of Champaca essential oil extract Disc and n-Hexane Discs on the test organisms - Disc diffusion method (Inhibition Zones in mm)

Test organisms	Essential oil Disc Diameter (mm) D_1	n-Hexane Control Disc Diameter (mm) D_2
Escherichia coli ATC10148	NI	NI
Pseudomonas aeruginosa	11	NI
Staphylococcus aureus ATCC 25923	NI	NI
Staphylococcus epidermis	9	NI

NI: *No Inhibition ;*
D1: *Diameter of zone of inhibition of essential oil disc.*
D2: *Diameter of zone of inhibition of hexane control disc.*

From the results presented in the table, it is clear that 25% inhibition was observed in the case of *Staphylococcus aureus.* It was observed that 25% of growth on the slant from the mouth of Durham's tube was inhibited by the essential oil extract. No such inhibition was seen for the essential oil extract in case of the other three organisms. It is also observed that n-Hexane, which was used a control, did not show any inhibition to any of the test organisms. The growth was present on the whole slant in case of the hexane tube. After 24 hours it was seen that the essential oil extract and the hexane had completely volatilized.

Michelia champaca essential oil extract was used to screen the anti microbial activity of the essential oil . This time the standard disc diffusion method was performed against four test organisms. The results of the test were obtained after 24 hours and the results are tabulated in table 3.

It can be seen that essential oil extract was found to be slightly active against the Gram positive test organisms.the activity of the essential oil was not found against Gram negative test organisms.the n- Hexane discs which were put as controls, did not show any inhibition against all the test organisms as can be seen from the table.the solvent thus does not have any antibacterial activity.

The activity of the essential oil extract was seen against standard strains of *Staphylococcus aureus and Staphylococcusepidermidis* as can be noted from table. It is also observed from the table that the essential oil showed an inhibitory zone diameter of 11 mm against *Staphylococcus aureus.* The essential oil extract also showed a very low activity against *Staphylococcus epidermidis,* zone of 9 mm diameter. No activity was observed against the other organisms.

CONCLUSION

The bioassay of the essential oil of *Michelia champaca* did not show encouraging results. However, a slight inhibition was found against *Staphylococcus aureus,* a Gram-positive test organism by the susceptibility disc method. A 25% inhibition was observed against *Staphylococcus aureus* by the Durham's diffusion tube assay indicating anti-microbial principles of lower potency in the champaca essential oil extract. The compound Farnesol seems to be the major bioactive principle as evident from the present study. In contrast, anti-microbial compounds of broad spectrum activity were observed in the alcohol extract of leaves, bark and stem of Michelia champaca and this activity may be related to the presence of alkaloids. The alkaloid Liriodenine has been reported having anti microbial activity (Khan et al, 2002). It

appears that the bioactive alkaloids are absent in the flowers and thus none of the other components possess effective or potent anti-microbial activity.

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RESEARCH ARTICLE

Bioresources as the tool for Biodiversity Management

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ABSTRACT

Water management in general takes account of biodiversity and conservation aspects, but further some protective measures are needed. Cost of water management directly or indirectly influences the aquatic ecosystem. Biotic and abiotic factors are both independent and interdependent resources. Multispecies communities like plankton, fishes and macrophytes are bioresources which are essential for the stabilization of ecosystem. Bioindicators and bioresources are both responsible to maintain the food chain of pond ecosystem. Species composition and biomass distribution are important for affecting the transfer of energy in food chain of pond. Phytoplankton represents the base of primary producer in aquatic ecosystem and plays a major role in the global cycling of carbon, nitrogen, phosphorous and other elements; and by this they help in regulation of the earth's climate. Bioresources are the natural bioindicators of pollution in the water body. Bioindicators are anthropogenically induced which affects biomolecules, their biochemical and physiological parameters that are casually linked to the different levels of biological organisation. Sometimes the reason behind loss of biodiversity is due to competition between bioresources in a limited space. Present investigation is an attempt to study and understand the basic status in hydrobiology and productivity possibility of reservoir.

Keywords: Bioresources, Bioindicators, Biodiversity, Management, Biomass Distribution

INTRODUCTION

Water is the mirror of civilization, since the origin of life. Almost all the living organisms prefer to live in water. Availability and

quality of water are important for determination of the quality of aquatic environment. Management of water resources and biodiversity of aquatic body is important for society. Fresh water formation are the cheapest and most accessible source for maintaining biodiversity by management of bioresources as they make the water reservoir polluted or pollution free by showing their presence or absence. According to Bourdean and Threshow (1978) pollution is an environmental change which alters species diversity for a particular biotype, also causing successive changes in the nutrient status of the water area associated with changes in the biota.

The onset of entropy is characterised by a marked increase in primary production site usually in the form of phytoplankton with the frequent occurrence of algae blooms. Increase in primary productivity leads to a corresponding increase in the secondary productivity. As the increase in phytoplankton occurs, in most cases it decreases the transparency which may render water harmful to fish and cattle. Wetzel (2006) has described that limnology is the study of functional relationship and productivity of fresh water biotic environmental parameter.

MATERIAL AND METHODS

Samples were collected randomly in each month from January, 2014 to December, 2014 from the selected sites of Jawaharlal Bal Udyan wetlands of Bhopal. The plankton forms were collected by using a small meshed plankton net of nylobolting silk (25 number) followed by filtrating a known volume of water sample through it. Then the plankton net was transferred in 50 ml bottle and the plankton samples were preserved in 5% neutralized formalin and a few drops of glycerine were also added to it after collection. The sample was allowed to stand for a day to acquire further concentration. After having the planktons settle down at the bottom of the bottle, the supernatant plankton free water was removed with the help of a pipette and the sample was reduced to a described volume. Monthly and seasonal variation in various physico-chemical characteristics and their correlation with the biotic communities: abundance distribution and occurrence of phyto and zooplankton; qualitative observation on available macrophytes; and fish fauna of the pond. These studies helped to understand the proper biomaintenance of aquatic body with respect to their biodiversity.

Primary productivity was determined by measuring oxygen produced during photosynthesis. Volumetric estimation was done in the laboratory. Phytoplankton and Zooplankton were collected by filtration method and for quantitative study of phytoplankton and zooplankton each replicate was counted under research microscope by drop count sedimentation method. Phytoplanktons were counted species wise seasonally. Identification of Zooplankton and Phytoplankton was done according to Needham & Needham (1962) and Adoni (1985).

Macrophytes were collected from 2-3 meters from the shore line of the pond. Fishes were collected by fishermen as it was a fish stocking pond. According to Patil et al. (1983), the maximum value of water temperature is observed in summer and the minimum in winter. Present study also showed a significant correlation between air temperature and pH(r+0.58. Ω≤0.05).Hence with the increase in temperature, pH moves towards alkaline side thus accelerating the rate of photosynthesis due to consumption of carbon dioxide.

However in the present investigation water temperature shows negative correlation with dissolved oxygen(r=-0.58, p≤o.1).During the course of study it was observed that during the period of high temperature, low oxygen content was present. In the pond, carbon dioxide was present throughout the year. It ranges from 0.3mg/L - 1mg/L. The maximum value was recorded during August and minimum value during April.

RESULTS AND DISCUSSION

During studies, maximum atmospheric temperature was registered during May. Water temperature also reached its maximum during summer. The air and water temperature is closely associated with each other in the case of the smaller size of the water body (Welch, 1952; Anderson, 1970; Hopkins 1971). According to them smaller the water body, the more quickly it would react to the change in atmospheric temperature. It is evident that sunshine hours and temperature, influences the solubility of gases in water particularly that of carbon dioxide and oxygen, high temperature accelerate the process of decay of organic matter resulting in liberation of large quantities of CO_2, so the consumption of CO_2 was depended on the bioresources (Phytoplankton, Zooplankton, macrophytes and fishes) present in the water body. Oxygen is the important fundamental parameter of fresh water bodies and is essential for the metabolism of the aquatic bioresources that are housing aerobic respiratory biochemistry. Dissolved oxygen provides valuable information about the biological reaction going in water body. In the pond, the dissolved oxygen was found to fluctuate from 5.3 mg/L and 12.4 mg/L.

Water acts as a medium for growth and development of aquatic biota, so there was a need to know the actual role of bioresources in maintaining biodiversity of a Jawahar Bal Udyan Pond in Bhopal. Species composition and their metabolic activity can affect the pattern of aquatic life. The bioresources shows the variation due to sewage entrance and due to these, during the study period it was observed that limno-chemical properties of an aquatic body could be changed to determine the nature of aquatic body. Weltch (1935) has remarked that it should be understood in advance that each physical and chemical influence described is not purely physical or chemical. This may be because of the increased metabolic activity of the biota. This was observed also by Pearsall (1921); Bohra & Bhargava (1977) and Vass & Sachlan (1953). Transparency is an index of productivity because it controls the structural and behavioural characteristic of bioresources. It adversely affects the primary productivity. During the course of present study the maximum transparency measured by Secchi disc was recorded during March. The maximum value in visibility during the summer may be attributed to the absence of macrophytes and low level of water. All living organisms depend upon oxygen in order to maintain metabolic process that produce energy for growth; so for biodiversity maintenance, bioresources management worked as a tool to maintain the higher form of biological life in water as they are all dependent for food on each other to maintain their energy level in a system. According to Jhingran (1982) in natural water, carbon dioxide is liberated from various sources; due to activity of animals and plants, bacterial decomposition of organic matter.

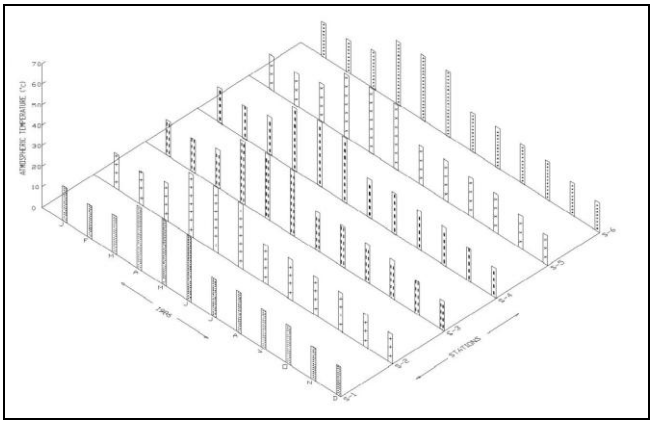


Fig. 1 : Annual atmospheric temperature of water body at different stations

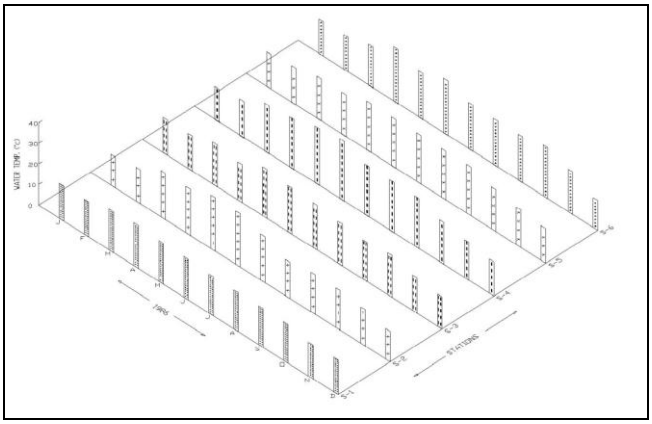


Fig. 2: Annual water temperature of water body at different stations

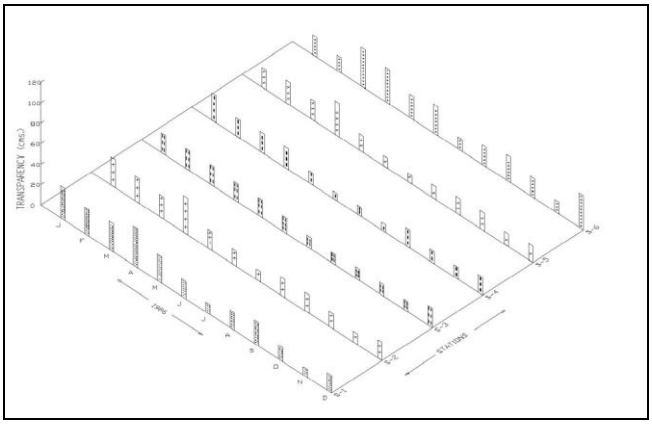
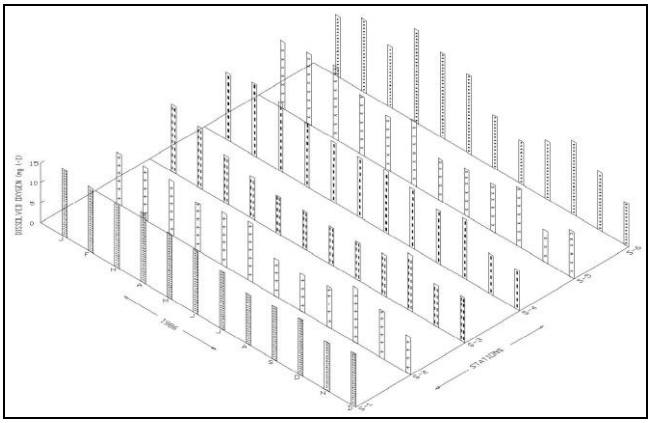


Fig. 3: Annual water transparency of water body at different stations



Fig, 4: Annual dissolved oxygen variation of water body at different stations

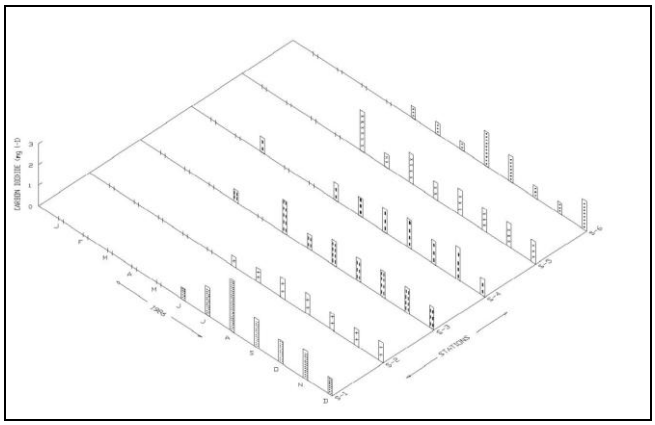


Fig. 5: Annual carbon dioxide variation of water body at different stations

The light and dark bottle method of measuring community metabolism by change in dissolved oxygen has been very valuable in measuring biological diversity in a water body. Biological productivity is a concept of organic synthesis potential which measures the ability of biological population as the bioresources present in the water body. Seasonal studies were done. High rate of productivity during summer was probably due to bright sunshine maintaining high temperature. The lower value of productivity during monsoon may be because of the increase in turbidity. Respiration rate was highest during winter; in present study this may be due to low temperature. Sreenivasan (1964) in Amravathy reservoir observed maximum production in April. Khan and Siddiqui (1971) also recorded high gross primary production value from March to May in pond Moat, Aligarh. Similar in Sathiar reservoir, Kannar and Jobs (1980) observed that production was high between April and July. From the present study it was evident that productivity rates increases from winter and reach at its peak in summer. Phytoplankton contributed much on the environmental factor as they affect the dynamics of the aquatic system. Numerical species diversity is the most reliable method to show relationship between species population and whole communities, often provide more reliable indicators than single species (Odum 1971).

Phytoplanktons were mostly represented by the group Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae. In total 20 taxa were observed at this pond. Maximum were recorded during January, February, April, May, October and November; while minimum 12 taxa were recorded during June and July. According to Senthilkumar and Shivkumar (2008); the phytoplankton density was high during summer and low during the winter season.

Valecha (1985) identified 48 species in the lower lake of Bhopal. During the present study total plankton population was highest (28000 organisms /litre) in May and lowest (10600 organisms/litre) in July. No definite increasing and decreasing pattern was observed during study period. During the present study the group Chlorophyceae dominated throughout the year. According to Valecha (1985) the dominance of Chlorophyceac in Lower Lake, Bhopal was observed. According to Tas and Gonulol(2007), the shallow lake of Turkey has a high biodiversity due to species richness as they identified total 104 taxa of phytoplanktons in the shallow lake.

Zooplankton community is a major link in the energy transfer at secondary level; and being heterotrophic in nature plays a key role in the cycle of organic matter in the aquatic ecosystem. These organisms either directly or indirectly act as food for fishes and other fish food organisms. Zooplankton acts as indicator of trophic condition of the environment; as they are easier to identify and respond more quickly to environmental changes then the fishes. Moreover the environmental selection depending upon various physico-chemical and biological factors, not only restricts the number of species and their biomass but also triggers their seasonal polymorphism.

Zooplankton community belongs to three major groups i.e. Rotifer, Cladocera and Copepoda. Maximum density of Zooplankton (867 organisms/litre) was noted in March and minimum density of Zooplankton was recorded in June (247 organisms/litre). Chourasia and Adoni (1985) observed Zooplankton component of the Eagar Lake mainly consisting of the four major group i.e. Protozoa, Rotifer, Cledocera and Copepoda. Hawkins (1988) concluded that Zooplankton population consisted of Rotifiers, Cladocera and Copepoda. According to Wanganeo (2007) and Khan (2014); Zooplankton fauna or their association can be used as useful means for the assessment of water pollution.

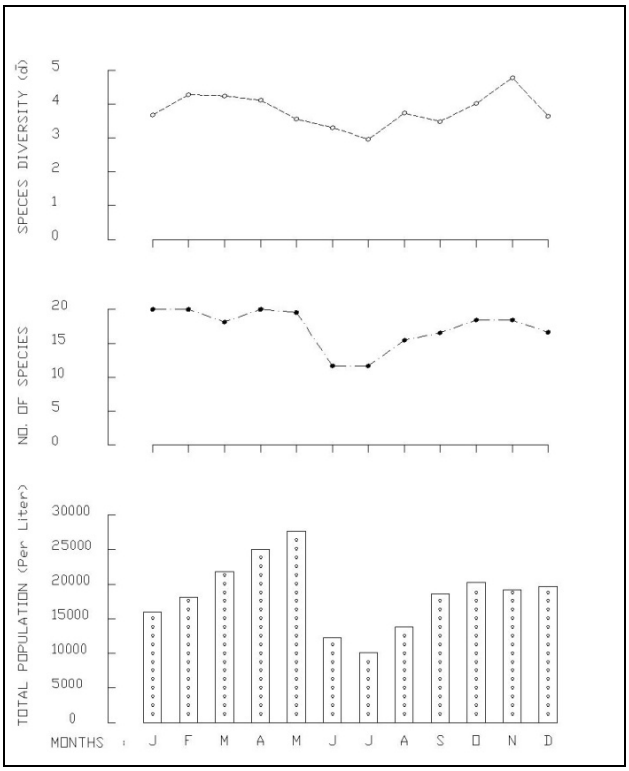


Fig. 6: Total Population, total Species & Species Diversity of Phytoplankton

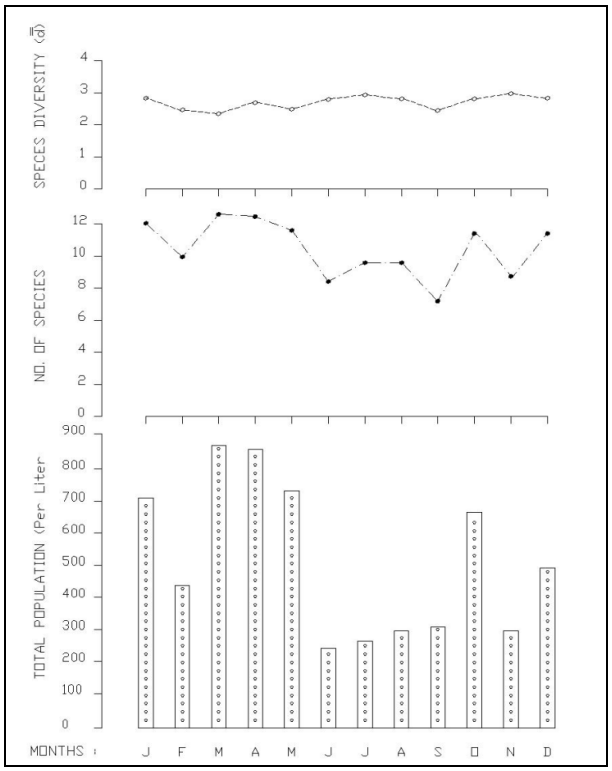


Fig. 7: Total Population, total Species & Species Diversity of Zooplankton

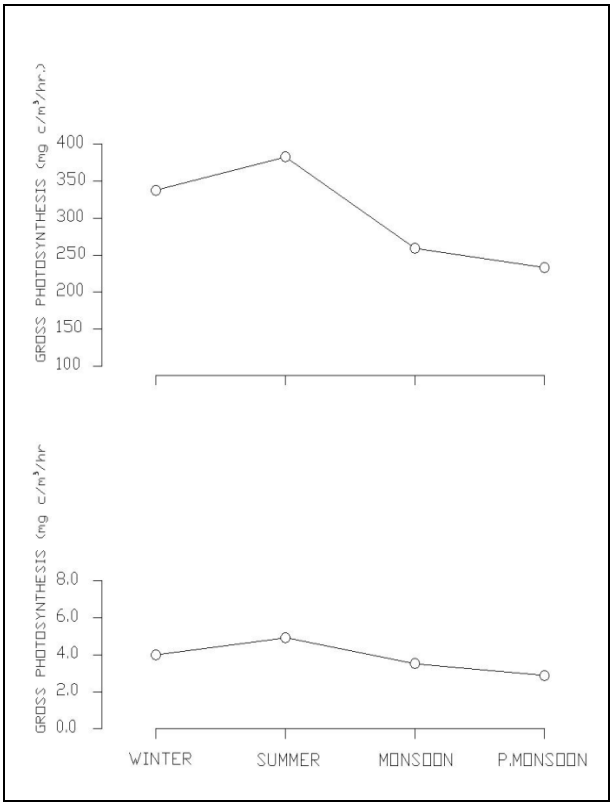


Fig. 8: Seasonal Variation in Primary Productivity, 1986

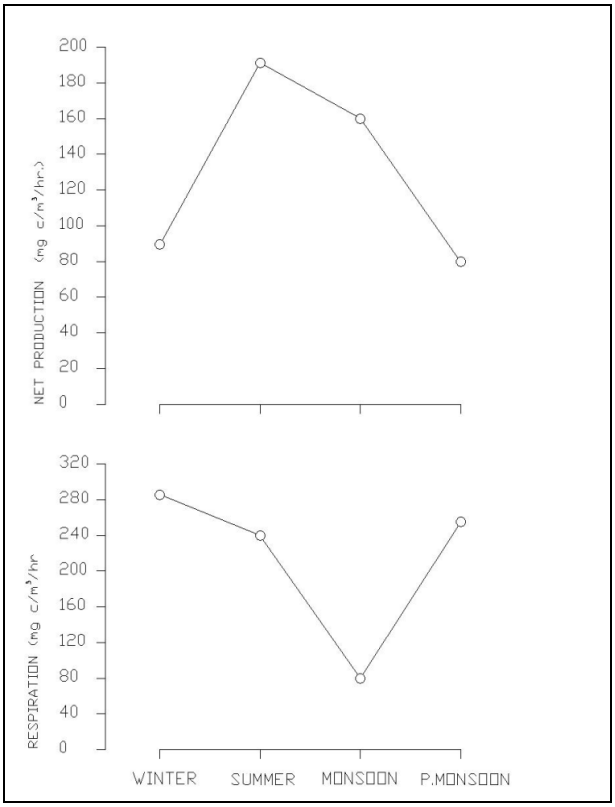


Fig. 9: Seasonal Variation in Primary Productivity, 1986

Aquatic macrophytes were observed especially in the form of various aquatic weeds. Lalman and Dixit(1986) reviewed the morphometry of lake and distribution of macrophytes of Tarairegion of North Eastern Uttar Pradesh. The macrophytes were collected from whole water body and classified according to their biological types. Total nine species of macrophytes were encountered.

The qualitative survey was done during present study. Total nine species were found in Jawahar Bal Udyan pond which were categorised into three forms i.e. emerged, submerged and free-floating. Singh and Rai (1984) observed hydrophytes in engineering college Lake Jabalpur. Joshi et al. (1987) noted the absence of both chara and nitella which may be considered to be an indicator of eutrophy. The ultimate aim of studying fishery bioresources of the pond was that fish forms a major part of the valuable edible material and also has a great economic value to the general public.

In the present study five families and nine species of fishes had been encountered throughout the period of investigation. Low production of fishes was associated with high turbidity condition. Jhigrar (1982) noted that fishes die at about 11pH. According to Singhai (1986) Zooplankton was useful food for fish growth while the phytoplankton had harmful effect on fishes. During the study period, pond was used as a stocking pond for fish production to increase the production as well as maintaining the biota of the water body.

CONCLUSION

Bioresources are beneficial as bioindicators which increases the productivity of water as water is a natural resource. With the increase in the nutrients, the number of phytoplankton also increases thereby increasing the primary productivity of water. This also increases the fish fauna of the water body.

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RESEARCH ARTICLE

Rotifers response to alkalinity and hardness of Pandu lake Bodhan

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ABSTRACT

Rotifers being an important food resource for fishes, act as an indicator of trophic status besides water quality of an aquatic ecosystem. The impact of alkalinity and hardness on Rotifer diversity of Pandu lake was evaluated for a period of two years, August 2002 to July 2004. The total alkalinity and total hardness was above the permissible limits and the rotifers were found throughout the study period indicating the eutrophic status of Pandu lake.

KEYWORDS: Alkalinity, Hardness, Rotifers, Pandu lake

INTRODUCTION

Zooplankton occupies an important position in the trophic structure and plays the major role in the energy transfer in an aquatic ecosystem. Rotifers commonly known as wheel animalcules are the most important soft-bodied metazoans having a very short life cycle among the plankton (Jagadeeshappa et al., 2013). Rotifers inhabiting lake ecosystems constitute the major component of zooplanktons. They are consumers of microorganisms such as bacteria, algae, and ciliates. Some species are detritivorous. Thus rotifers play an important role in the trophic structure in freshwater ecosystems. Some rotifer species are also used as indicators of water trophy (Sulehria et al., 2009). Alkalinity is a measure of buffering capacity of water and is important for aquatic life in a fresh water system because it equilibrate the pH ranges that occur as a result of photosynthetic activity of plants in water (Kaushik and Saxena, 1999). Hardness of water is mainly due to the presence of calcium and magnesium ions and is an important indicator of

toxic effect of poisonous elements present in water (Tiwari, 2001). The objective of present study is to investigate the impact of total alkalinity and hardness on rotifer diversity of Pandu lake.

MATERIAL AND METHODS

Bodhan town is spread 21.36 km2. The town Bodhan is located at latitude 18◦39 36 N and longitude 77◦52 47 E. The present lake Pandu is located on the North side of Bodhan town near residential localities. Free catchment area of the lake is 1.65 square miles. The total capacity of Pandu Lake is 9.44 Mcft. Total spreading area of Pandu Lake is 109.22 ha. The depth of Pandu Lake is 7 ft .Alkalinty and Hardness of water samples estimated by standard methods (APHA 1989). Zooplankton samples were obtained by passing 50 l water through plankton net in each depth. Zooplankton samples were preserved in 4% formalin. Identification of Rotifers was done with the help of fresh water biology Edmondson (1965) Counting of organisms was done using Sedgwick- Rafter counter and the dilution technique and the population density of Zooplankton is represented per liter of water.

RESULTS AND DISCUSSION

The total alkalinity ranged from 212 mg/l to 350mg/l (Fig. 1). The lowest value noted during September 2002 and maximum during March 2003. High alkalinity values are indicative of the eutrophic nature of Pandu Lake. Munawar (1970) also observed high alkalinity in the eutrophic waters. Higher values of total alkalinity might be due to the presence of excess of CO_2 produced as a result of decomposition processes coupled with mixing of sewage and industrial effluents. Similar observations were recorded by Palharya et al (1993).

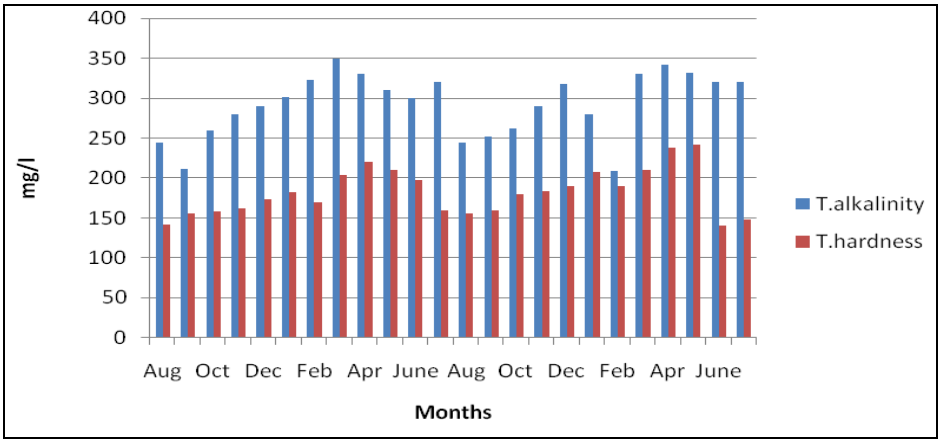

Fig. 1. Monthly Variations of Total Alkalinity and Total Hardness (mg/l) of Pandu lake

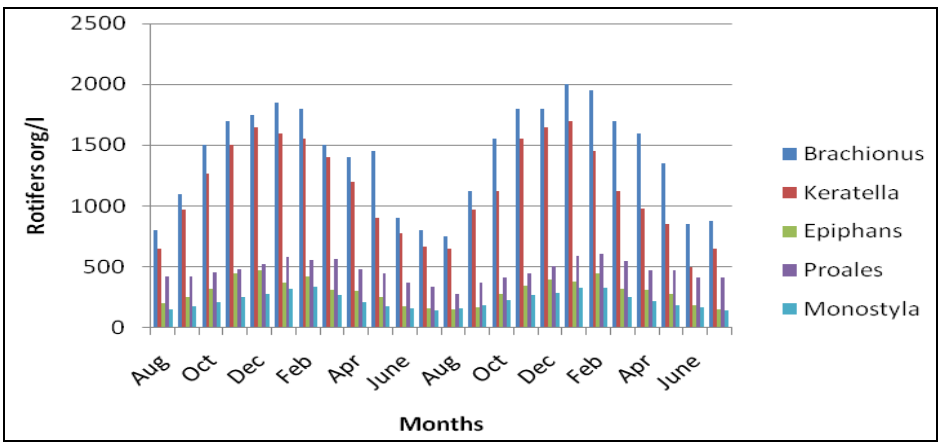

Fig. 2. Monthly Variations of Rotifers (org/l) of Pandu lake

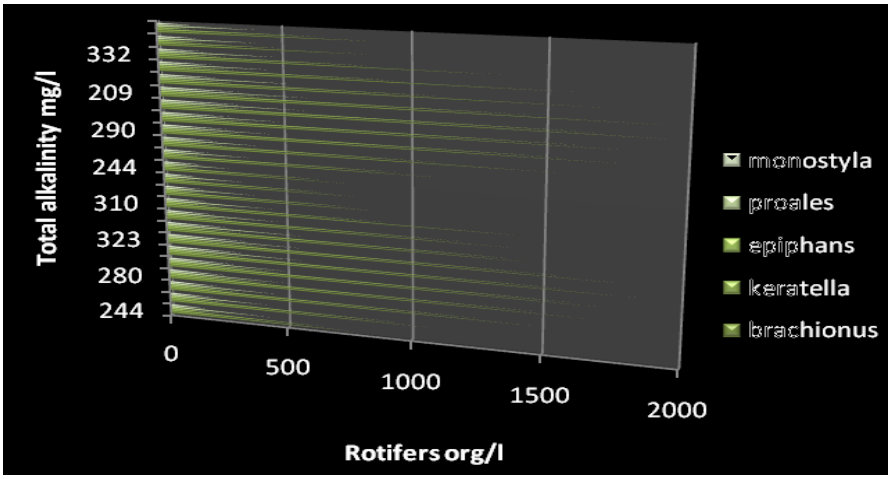

Fig. 3. Total alkalinity Vs Rotifers

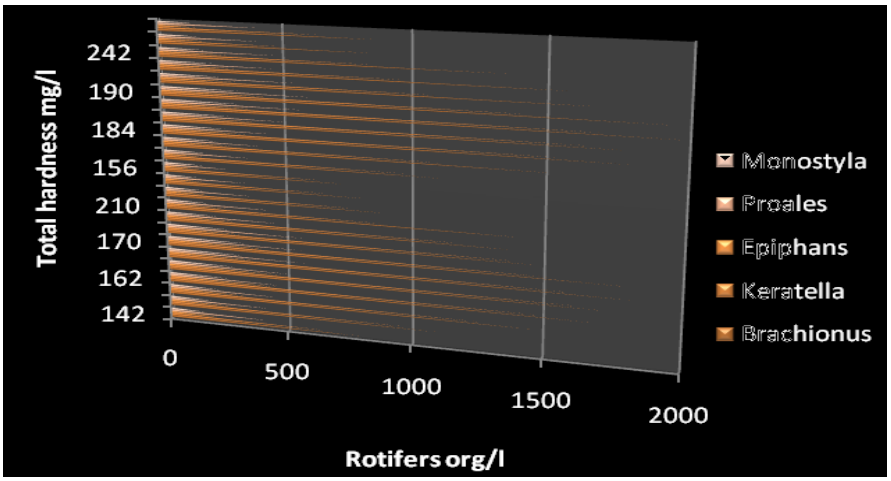

Fig. 4. Total hardness Vs Rotifers

The total hardness varied between 140 and 254 mg/l (Fig.1). The values of total hardness suggest besides leaching of rocks, evaporation of water and regular addition of large quantities of sewage and detergents into the lake from nearby residential localities. Water with hardness values more than 180 mg/l is very hard; in this respect water of Pandu is very hard. WHO (1984) permissible limit for total hardness is 200mg/l ad ISI limit is 300mg/l. Todd (1995) suggested that the values between 150 to 300 mg/l of total hardness means water is very hard and value greater than 300 mg/l means water is extremely hard. From the above discussions the hardness of Pandu Lake is higher than permissible limit.

The population of rotifers was found to be present in the lake water during almost every month (Fig. 2) suggesting that rotifers could tolerate organic pollution of sewage origin. Rotifers observed were Brachionus, Keratella, Epiphans, Monostyla, and Proales . Brachionus was found to be present throughout the study period. Its density was found to be more in January to May. The population of rotifers was found high from November to January and showed a single peak in April. This confirms findings of summer periodicity of rotifers as also observed by Sinha and Sinha (1993). Balkhi et al., (1984) found rotifers in water where the temperature was as low as 5^0C while Sharma and Shrivastava (1986) recorded rotifers at temperature as high as 35^0C. Both the temperature and dissolved oxygen of this lake were found to be nominal for the growth of rotifers. Rotifers have no effect on abiotic factors as the population density of proales and they were highly abundant same thing expressing themselves in the form of blooms. Rotifers population indicates pollution from inorganic

matter due to the direct entry of untreated domestic sewage into the lake.

Monostyla exhibited no significant correlation with alkalinity and hardness. Keratella and Proales are positively correlated with total alkalinity and no significant correlation with the total hardness. Brachionus poorly correlated at insignificant levels and Epiphans are positively correlated with total alkalinity and hardness (Fig. 3 and 4).

CONCLUSION

The present study reveals that Brachionus is the dominant genus throughout the investigation period indicating the eutrophic status of the Pandu lake.

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RESEARCH ARTICLE

A floristic survey of flowering plants from Vidyabharati Mahavidyalya Campus, Amravati (Maharashtra) India

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ABSTRACT

One of the grand tasks of current taxonomy is to prepare a checklist of plants of the globe. This work is largely based on collecting information from regional floras and databases. Till this date, the progress is relatively slow, as the number of common names, synonyms, poorly resolved aggregates is high. For this purpose regional flora, checklists and databases with reliable taxonomy and complete coverage of critically examined data are required. The majority of novelties come from the tropics; but certain areas remain poorly explored as well, and numerous species in these areas still await recognition. In the present work, the studied area is Vidyabharati Mahavidyalaya campus which is situated in the prime location of the Amravati city. Amravati is a district in the state of Maharashtra with its district headquarters situated at 20°55′33″ N and 77° 45′53″ E. The district is situated at 343m (1,125ft.) asl. The present study deals with the floristic diversity of campus in the former sense, i.e., the number of individual species in the area. The present paper attempts to highlight the diversity of vast plant resources of the campus in a conservation perspective. A total of 91 species of flowering plants are documented in which 43 were herbs, 25 shrubs, and 24 angiospermic trees distributed in 22, 13, and 12 families respectively.

Key words: taxonomy, explored, survey, diversity, conservation

INTRODUCTION

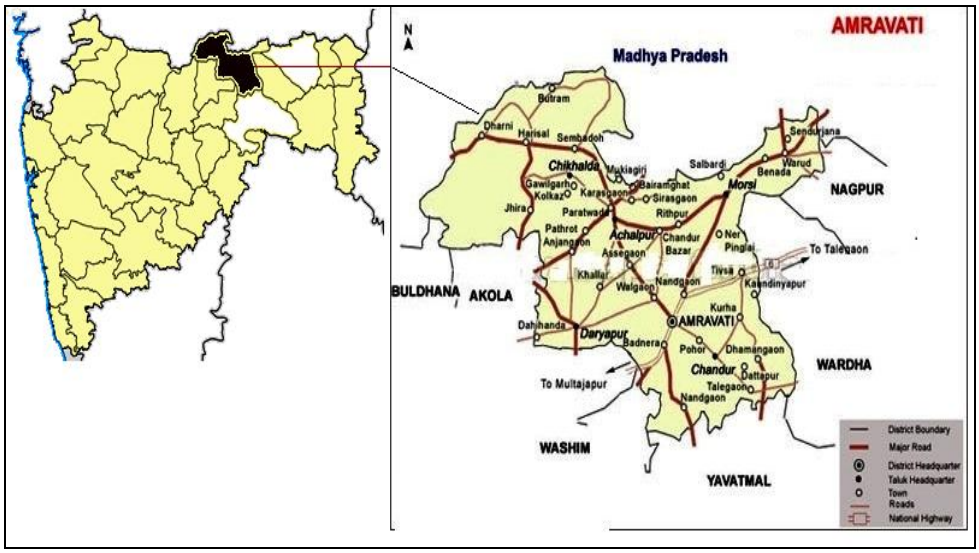
From the very beginning of inception of human beings on the earth man has relied on plants to fulfill his basic needs for his survival. Plants provide food, shelter and health. It is estimated

that about ten million species of plants inhabit the planet earth of which, however only 1.7 million species are known to science. It is therefore the need of the hour to explore the floristic wealth of the earth so as to know what we have. The plant diversity however is under serious threat due to various anthropogenic factors and many plant species are disappearing. Many species are becoming extinct even before their discovery. This scenario necessitates the urgent need of conservation of this diversity. To formulate various strategies for this purpose, the first important step is to explore and inventories the flora. Keeping this perspective in view the present studies were conducted to explore and inventorize the plant species. Therefore an attempt has been made to study the plant species present in the campus. Different Morphological characters are being studied like habit, height, leaf, inflorescence, flowers, and fruits etc representing diversity of plants in the campus of Vidyabharati Mahavidyalaya college.

Floristic diversity can be defined as the variety and variability of plants in a given region. It refers to the number of types or taxa in a given region or group. Floristic diversity can be measured at any level from overall global diversity to ecosystem, community, species, populations, individuals and even to genes within a single individual. The present survey deals with the floristic diversity of college campus in the former sense, i.e., the number of individual species in the area. The present paper attempts to highlight the diversity of vast plant resources of the college campus in a conservation perspective. In this survey we have focused only on the flowering plants of the campus Although the lower groups of plants (Pteridophytes, Lichens, Bryophytes) form a important part of vegetation and contribute significantly to the floristic diversity, they have been excluded in the present discussion.

Area of study:

Amravati is a district in the state of Maharashtra with its district headquarters situated at 20°55′33" N and 77° 45′53" E. The district is situated at 343m (1,125ft.) asl. The Amravati district has an area of 270 km^2. Vidyabharati College is situated in the prime location of the Amravati city. It has a set of beautiful buildings along with a play ground & Gardens situated over the 7.77 acres of a piece of a land. The total area under the gardens is about 30,000 sq.feet. The study area has well demarcated four seasons as a hot summer, heavily raining monsoon, a brief autumn and a mild winter. The area has sub tropical climatic conditions with ample rainfall in the monsoon resulting in a rich diversity of vascular plants.



Map: Amravati a district in the state of Maharashtra

MATERIAL AND METHODS

Plants were observed during all seasons of the year 2012-13. During observation field notes were recorded in field notebooks and voucher specimens of these species were collected. The collected specimens were processed using usual taxonomic methods of drying and mounting. The specimens were identified with the help of existing literature (Bentham & Hooker, 1862-83 ; Cooke, 1901-1908; Dhore, 1986; Naik, 1966,1977,1998; Singh *et al.*,2000; Singh *et al*; 2001) and have been preserved in the herbarium of Department of Botany, Vidya Bharati Mahavidyalya, Amravati.

RESULTS AND DISCUSSION

The Present study deals with the documentation of the total number of herbs, shrubs and angiospermic trees, which are the native of different countries. Some of these plants have been brought here from different areas of the country & cultivated over here in the garden, and some grow wildly in this area. A list of plant species in the catchment area starting by herbs, then shrubs, and at last angiospermic trees. A total of **91** species of flowering plants are documented in which **43** were herbs, **25** shrubs, and **24** angiospermic trees distributed in **22**, **13**, and **12** families respectively.

Table 1 : list of herbs

Sr. No.	Botanical Name	Family
1	*Vernonia cineria* (L.)Less.	Asteraceae
2	*Calendula officinalis* L.	Asteraceae
3	*Zinnia peruviana* (L)	Asteraceae
4	*Zinnia angustifolia* kunth.	Asteraceae
5	*Blainvillea acmella* L.	Amaranthaceae
6	*Aerva Lanata* (L.) Juss.	Amaranthaceae
7	*Achyranthus aspera* L.	Amaranthaceae
8	*Amaranthus poligonides* L.	Amaranthaceae
9	*Andrographis paniculata* (Burm.f.)Wall ex Ness	Acanthaceae
10	*Diplocyclous palmatus* L.	Cucurbitaceae
11	*Cocculus hirsutus* (L.) Deils	Menisparnaceae
12	*Oxalis corniculata* L.	Oxalideaceae
13	*Colocasia esculanta* (L.) Schott	Araceae
14	*Ocimum sanctum* L.	Lamiaceae
15	*Catharanthus roseus* (L.)	Apocynaceae
16	*Datura metal* L.	Solanaceae
17	*Withania somnifera* (L) Dunal.	Solanaceae
18	*Acalypha indica* L.	Euphorbiaceae
19	*Curcuma longa* L.	Zingiberaceae
20	*Zingiber officinale* Rosc.	Zingiberaceae
21	*Ipomoea cairica* (L.) Sweet.	Convolvulaceae
22	*Passioflora edulis* Sims.	Passifloraceae
23	*Aloe vera* L.	Liliaceae
24	*Asparagus racemosus* (L.) Willd.	Liliaceae
25	*Cissus qudrangularis* L.	Vitaceae
26	*Agave americana* (L.)A.L.Juss. ex Schutt	Agavaceae
27	*Hymenocallis littoralis* (Jacq.)	Amaryllidaceae

Table No.1 : Continued...

Sr. No.	Botanical Name	Family
28	*Jasminum auriculatum* Roxb.	Oleaceae
29	*Dianthus chinensis* L.	Caryophyllaceae
30	*Trigonella foenumgraecum* L.	Fabaceae
31	*Cynodon dactylon* (L.)Pers	Poaceae
32	*Dicanthium annulatum* (Hook.f.) Blatt. & Mc C.	Poaceae
33	*Lophopogon tridentatus* Hack.	Poaceae
34	*Andropogon pumilus* Roxb.	Poaceae
35	*Aristida hystrix* L.F.	Poaceae
36	*Chloris virgata* Swartz.	Poaceae
37	*Dactylotenium aegyptium* (L) P.Beauv.	Poaceae
38	*Eleusine indica*(L.)Gaertn.	Poaceae
39	*Setaria pumilla* (poir)R.	Poaceae
40	*Melanocenchris jacquemontii* Jaub.and Spach.	Poaceae
41	*Alpuda mutica*	Poaceae
42	*Eragrostis namaquensis* Schard var.*diplachnoides* (Steud)	Poaceae
43	*Eragrostis tanella*	Poaceae

Table No. 2: List of Shurbs

Sr. No	Botanical name	Family
1	*Hibiscus rosa-sinensis* L.	Malvaceae
2	*Abelmoschus moschatus* L.	Malvaceae
3	*Lawsonia inermis* L.	Lithraceae
4	*Murraya koenigii* (L.) Spr.	Rutaceae
5	*Citrus aurantiifolia* (Christm.) Sw.	Rutaceae
6	*Hamelia patens* Jacq.	Rubiaceae
7	*Ixora coccinea* L.	Rubiaceae
8	*Coffee arabica* Ritter Ron.	Rubiaceae
9	*Nyctanthes arbortristis* L.	Oleaceae
10	*Nerium oleander* L.	Apocynaceae
11	*Tabernaemontana divaricata* (L.) R. Br.	Apocynaceae
12	*Calotropis procera* (Ait) R. Br.	Asclepiadaceae
13	*Solanum nigrum* L.	Solanaceae
14	*Barleria cristata* L. var. *cristata*	Acanthaceae
15	*Adhatoda beddomei* Hong Gao	Acanthaceae
16	*Vitex trifolia* L.	Verbenaceae
17	*Lantana camara* L. var. *aculeatea*(L.) Mold	Verbenaceae
18	*Jatropha curcas* L.	Euphorbiaceae
19	*Ricinus communis* L.	Euphorbiaceae
20	*Acalypha wilkesiana* Muell. Arg.	Euphorbiaceae
21	*Euphorbia tithymaloides* L.	Euphorbiaceae
22	*Cajanus cajan*(L.)Millsp DC.nom. cons.	Fabaceae
23	*Calliandra calothyrsus* (Meisn.)	Fabaceae: Mimosoideae
24	*Indigofera tinctoria* L.	Fabaceae: Papilionaceae
25	*Punica granatum* L.	Punicaceae

Table No. 3: List of Angiospermic Trees

Sr. No	Botanical name	Family
1	*Azardirecta indica* A. Juss.	Meliaceae
2	*Ficus benghalensis* L.	Moraceae
3	*Ficus religiosa* L.	Moraceae
4	*Ficus glomerata* Roxb.	Moraceae
5	*Aegle marmelos* (L.) Corr.	Rutaceae
6	*Feronia limonia* L.	Rutaceae
7	*Mangifera indica* L.	Anacardiaceae
8	*Emblica officinalis* Gaertn.	Euphorbiaceae
9	*Psidium guajava* L.	Myrtaceae
10	*Santalum album* L.	Santalaceae
11	*Tectona grandis* L. f.	Verbenaceae
12	*Cocos nucifera* Linn.	Arecaceae
13	*Ziziphus mauritiana* L.	Rhamnaceae
14	*Butea monosperma* (Lam.) Taub.	Fabaceae
15	*Gliricidia sepium* (Jacq.)Walp.	Fabaceae
16	*Pongamia pinnata* (L.) pierre	Fabaceae

Catharanthus roseus

Hymenocallis littoralis

Calliandra calothyrsus

Nyctanthes arbortristis

Butea monosperma

Delonix regia

Eleusine indica

Themada quadrivalvis

Eragrostis namaquensis

Dianthus chinesis

Barleria cristata

Acalypha wilkesiana

Fig. 1:

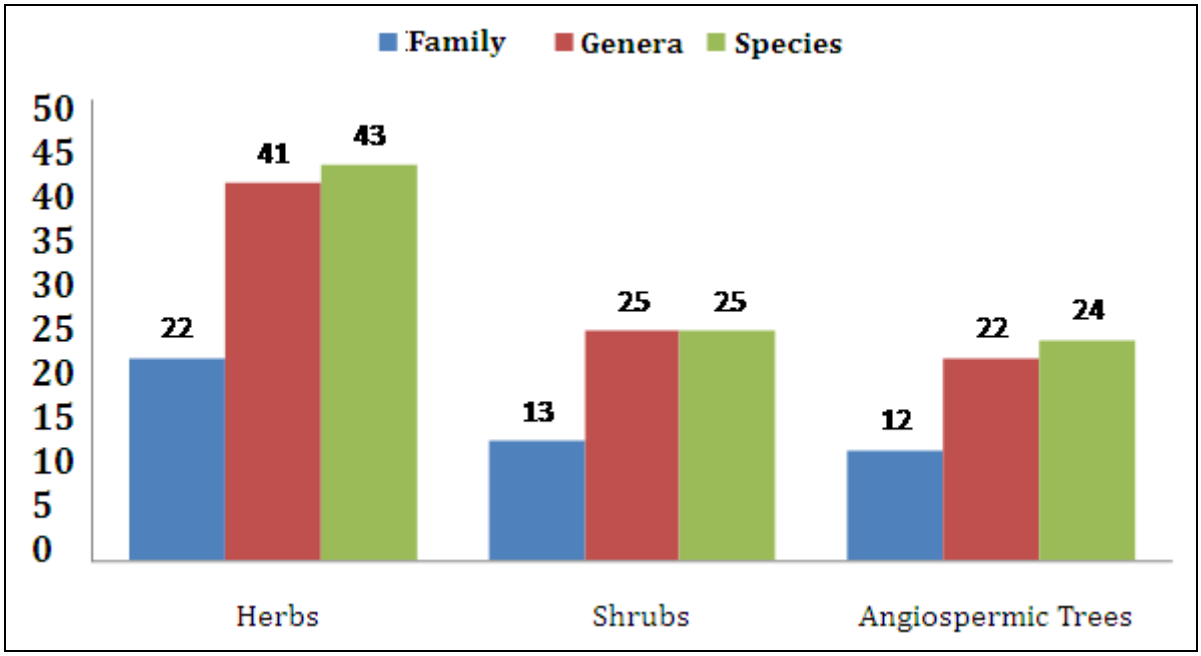


Fig. 2: showing number of Herbs, Shrubs, and Angiosperms with respect to their families, genera and species in the studied area

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RESEARCH ARTICLE

Studies on Productivity and Nutritivity of some popular Forages in winter season

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ABSTRACT

In present studies the three forage varieties Viz 'T9', variety of Lucerne, 'Kent', variety of Oat and 'Wordan', (S-99-1) variety of Berseem recommended by Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra) were cultivated at Maharashtra Sheli Va Mendhi Vikas Prakshetra, Bilakhed, Chalisgaon, Maharashtra during winter season of 1999 -2000. It was found that all the three varieties of the forage crops performed well and found suitable to cultivate in the area. In general the two essential mineral nutrients i.e. calcium and phosphorus found comparatively more in 'kent' variety of Oat and 'Wardan' variety of Berseem with better productivity. However, the overall performance of the T9 variety of lucerne is nutritionally superior to the other two varieties in percent crude protein, DM content and adequate quantities of the other nutrients.

Keywords: Forage, Lucerne, Berseem, Oat, Productivity, Nutritivity.

INTRODUCTION

The forages are important in agriculture and animal husbandry, they are the basic feed in the diet of livestock of all classes. The share of (green) forages is approximately 70% in livestock diet (Azam, 2010; Etuk *et al.,* 2012; Todkari, 2012). The supply of green forages in sufficient quantity is very important in livestock feeding in general and milchanimals in particular. The success of

any animal husbandry and dairy programme is usually known to depend upon four pillars, among them the supply of nutritious and balance feed through forage is very important (Patil, 1992, Bendre and Rathod, 2013a).

Farmers in this country are bestowed with a bounty of nature having large cafeteria of fodder crops to cattar the needs of cattle. These may be grown on farms to get nutritious fodder throughout the year. Several fodder crops has been recommended for cultivated and feeding to the cattle. These include cereals, fodder, perennial grasses, leguminous fodder crops etc. In order to evaluate the suitability of popular fodder crops in Chalisgaon region. In view of their production potential and nutritive value, present investigation was undertaken by using the recommended forage crop varieties viz. T9 variety of Lucern, 'Kent' variety of Oat and 'Wardan' variety of Berseen of Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra were cultivated at Maharashtra Sheli Va Mendhi Vikas Prakshetra, Bilakhed, Chalisgaon (M.S.), India.

MATERIALS AND METHODS

Three popular forages crops varieties viz. T9 variety of lucerne, 'kent' variety of berseen and 'Wardan' variety of Oat recommended by Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra were cultivated at "Maharashtra Sheliva Mendhi Vikas Prakshetra", Bilakhed (Chalisgaon), Maharashtra during winter in 1999-2000. The soil was analysed by Govt. Soil-Analysing laboratory, Jalgaon (1998) of its nutrient content before sowing. The soil was poor in phosphorous, moderate in nitrogen and potash with a normal pH 7.8.

A piece of land measuring about 270 sq.m. (15m x 18m) was prepared by ploughing and cross ploughings. While preparing the land "Compost" prepared on the farm was added at the rate of 3000 kg / ha. The land was than divided into 18 plots each with an area of 15 sq.m. for sowing the crops. Each crop was sown in nine replicates. The plots were arranged in Randomised Block Design. The crops were sown in rows, each plot bearing 10 rows spaced 30.5 cms. part. The fertilizers were applied only at the time of sowing as recommended dose by agriculture department. All crops were raised under irrigated conditions.

The crops were harvested from three replica every time, at preflowering stages as shown in Table.1 the weight of the green fodder obtained from each plot was measure and the samples of green fodder were immediately brought to the laboratory for analysis. The samples were chopped into 2 to 3 cm. piece and dried in an electric oven at 75 ± 5^0 C till constant weight for dry matter (DM) determination. Dried samples were ground to a fine powder and are used for estimation of crude protein. Nitrogen (N) content was determined in duplicate by MicroKejeldahl method (Bailey, 1967). The value of crude protein (CP) was expressed as N x 6.25. Hanneberg acid alkali gravimetric method outlined by Lees (1968) was used for the estimation of crude fibre (CF). Crudefat was measured with chloroform: Methanol (2:1) as a solvent using soxhlet extractor. AOAC (1970) methods were followed for the determination of ash, acid insoluble ash (AIA), nitrogen free extract (NFE), total carbohydrate (TC) and calcium (Ca) Method of Fiske and Subbha Row (1925) describe by Oser (1979) was followed for the determination of phosphorus (P).

RESULTS AND DISCUSSION

i) Oat - *Avena sativa* L

Popularly known as 'Javi' is an important rabi Fodder Crop in India. Its fodder is nutritious and palatable containing high percent of protein (Arora, *et al*., 1998). As a fodder it is an excellent and highly nutritive for milchlivestocks. The crop was cultivated during Oct 1999 to Feb. 2000 (Table-1) for yield measurement as well as to assess the nutrient composition of green fodder.

Table 1: Details of cultivation practices and harvesting of popular rabi fodder crops.

Crop	Cultivar	Date of Sowing	Seed rate (kg/ha)	Total fertilizers added(kg / ha)			Type of Cut	Date of harvest
				N	P	K		
Oat	Kent	20Oct. 1999	100	120	60	40	Ist Cut	30 Dec.1999
							IstRegrowth	30 Jan. 2000
							IIndRegrowth	28 Feb. 2000
Lucerne	T9	20 Oct. 1999	30	30	60	40	Ist Cut	30 Dec.1999
							Ist Regrowth	25 Jan. 2000
							IIndRegrowth	20 Feb. 2000
							IIIrd Regrowth	20 Mar. 2000
							IVth Regrowth	19 Apr. 2000
Berseem	Wardan	20 Oct. 1999	30	30	60	40	IstCut	30 Dec. 1999
							IstRegrowth	25 Jan. 2000
							IInd Regrowth	20 Feb. 2000

Table 2: Yield of green fodder, dry matter and crude protein from Popularrabi fodder crops.

Crop	Cultivar	Duration	Type of cut and age of crop in days		Green Fodder		Yield (kg *I* ha)		
					%DM	N% of DM	Green fodder	Dry matter	Crude protein
Oat	Kent	Oct.-Feb.	1st Cut	(70)	13.5	1.76	31174	4208	463
			I st Regrowth	(30)	22.0	1.66	17222	3789	398
			IIndRegrowth	(28)	24.0	1.66	10764	2583	261
			Total				**59160**	**10580**	**1122**
			Mean				**19720**	**3526**	**373**
			S.D.				**8510**	**688**	**83**
			C. V. (%)				**43.17**	**19.51**	**22.25**
Lucerne	T9	Oct.-Apr.	Ist Cut	(70)	27.0	3.68	6197	1673	385
			IstRegrowth	(25)	21.0	3.64	7083	1487	338
			IIndRegrowth	(25)	23.0	3.60	7083	1629	337
			IIIrdRegrowth	(30)	25.0	3.52	5312	1328	292
			IVth Regrowth	(30)	28.0	3.48	3586	1004	374
			Total	..			**29261**	**7121**	**1726**
			Mean				**5852**	**1424**	**345**
			S.D.				**1690**	**312**	**41**
			C.v. (%)				**28.87**	**21.91**	**11.88**
Berseem	Wardan	Oct.-Feb.	Ist Cut	(70)	24.0	3.52	30091	7222	1589
			Ist Regrowth	(25)	16.5	3.50	35445	5848	1279
			IInd Regrowth	(26)	20.0	3.44	6444	1289	277
			Total				**71980**	**14359**	**3145**
			Mean				**23993**	**4785**	**1048**
			S.D.				**1260**	**2535**	**560**
			CV. (%)				**52.51**	**52.96**	**53.43**

Table 3: Nutrient content of green fodder from Popularrabi fodder crops.

Crop	Cultivar	Date of harvest and Type of cut	% Dry Matter (OM)	% of DM								
				CP	CF	EE	Ash	AIA	NFE	TC	Ca	P
Oat	Kent	30 Dec. 1999Ic	13.5	11.00	23.8	7.00	15.3	0.54	42.90	66.7	1.01	0.45
		30 Jan. 2000 Ir	22.0	10.30	24.7	6.40	14.6	0.50	44.00	68.7	0.90	0.41
		28 Feb. 2000 IIr	24.0	10.06	26.0	6.90	15.1	0.49	41.94	67.9	0.92	0.43
Lucerne	T9	30 Dec.1999 Ic	27.0	23.00	25.0	4.90	10.8	-	36.30	61.3	1.90	0.25
		25 Jan. 2000 Ir.	21.0	22.75	28.0	4.20	10.7	-	34.35	62.3	1.92	0.27
		20 Feb. 2000 IIr	23.0	22.50	27.0	4.00	10.2	-	36.30	63.3	1.85	0.29
		20 Mar. 2000 IIIr	25.0	22.00	30.0	4.40	10.6	-	33.00	63.0	1.83	0.32
		19 Apr.2000 IIVr	28.0									
Berseem	Wardan	30 Dec. 1999 Ic	24.0	22.00	22.0	2.26	11.8	-	41.94	63.9	2.16	0.40
		25 Jan. 2000 Ir	16.5	21.80	25.0	2.12	11.2	-	39.88	64.8	2.10	0.35
		20 "Feb. 2000 IIr	20.0	21.50	28.0"	2.25	10.9	-	37.35	65.0	2.06 "	0.42

The crop yielded 31174, 4208 and 463 kg/ ha green fodder, dry matter and crude protein respectively in first cut (Table-1), while total yields work 59160, 10580 and 1122 kg/ ha green fodder, dry matter and crude protein respectively in 128 days, when it was harvested Thrice (1 cut + 2 regrowth). The results are in agreement to those recommended by Joshi *et al.,* (1993), Pisal *et al.,* (1993), Prasad (1993) Pradhan and Mishra (1994) and Rawat and Hazra (1997-98).

Percent dry matter (DM) on this crop was 10.5% at the 1st cut taken on 30 Dec. 1999 which increased to 24.0% at the 2nd regrowth harvested on 28th Feb. 2000.Table-2 gives chemical composition of green foliages from Oat. It was found tobe rich in protein containing from 10.06% to 11% protein content on DM basis. The values from crude protein content were at par with those recommended by Pradhan and Mishra (1994).

The crop contained 26% crude fibre and was rich in two essential mineral nutrients i.e. calcium and phosphorus. The results thus indicated suitability of this crop for fodder production. However, higher yields than those recorded during present trials were reported by Patil (1991).

ii) Berseem (Egyptian clover) *Trifolium alaxandrinum* L

Berseem, which was introduced from Egypt in 1904, has become a popular and potential forage legume in India for the cultivation during winter season under assured irrigated system (Joshi *et al.*, 1988). It is soft nutritious and palatable. 'Wardan' (S-99-1) variety of berseem was used for cultivation raised during Oct. 1999 to Feb. 2000 (Table-1). When it was harvested for 03 times in 121 days. It yielded 71980 kg/ha green fodder which was higher than that recorded with lucerne (Table-2) Nutritionally it was slightly inferior to lucerne containing 21.5 to 22% crude protein on DM basis (Table -3). In general the crop as rich in calcium and other essential nutrients. The yields recorded during present investigation were similar to those recorded by singh and Dixit (1990) and Hazra (1996).

iii) Lucerne - *Medicago sativa* L

Lucerne, highly productive leguminous fodder crop. It is called "queen" of fodder crops as it is nutritionally superior. It is cultivated at several places of Maharashtra. The crop is perential and

can be cut for 12 to 14 times in a year (Dahiphale *et al.,*, 1991, Bendre and Rathod, 2013b).

The T9 variety of lucerne harvested after 70 days (Table-1) and subsequently for the four regrowths till 19th April 2000 in 180 days, yielded, 29261 Kg/ ha. C.V. Value indicates T9 variety is more suitable than Oat and Berseem (Table-2). The yields were slightly lower than desire. Table-3 gives nutrient composition of lucerne which reveals its nutritional superiority. On an average the crop contained 21 to 28% DM. The DM was with 22 to 23% crude protein and adequate quantities of other nutrients. It is advisable to cultivated this crop as it is productive and it can supply nutritious fodder throughout the year.

CONCLUSION :

It was found that all the three varieties of the forage crops performed well and found suitable to cultivate in the area. In general the two essential mineral nutrients i.e. calcium and phosphorus found comparatively more in 'kent' variety of Oat and 'Wardan' variety of Berseem with better productivity. However, the overall performance of the T9 variety of lucerne is nutritionally superior to the other two varieties in percent crude protein, DM content and adequate quantities of the other nutrients.

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SHORT COMMUNICATION

Additions to the Fabaceae of Melghat Tiger Reserve (MTR), Maharashtra, India

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ABSTRACT

Fabaceae is the largest family, represented by total 116 species in the Melghat Tiger Reserve. Present paper deals with the addition of 02 new reports of Fabacae members namely, *Flemingia macrophylla* (Willd.) O. Ktze. ex Merr. and *Paracalyx scariosus* (Roxb.) Ali, to the flora of Melghat Tiger Reserve. Correct and updated citation, local name, a short description, along with distribution, is provided for future field work.

Keywords: Additions, Fabaceae, Melghat Tiger Reserve.

INTRODUCTION

Melghat Tiger Reserve (MTR) is situated in the mountainous region, the Gavilgarh hills of Satpuras in Dharni and Chikhaldara tahsils of Amravati District of Maharashtra state. Tiger reserve covers a total area of 1676.93 sqkms. The forest is of dry deciduous type and vegetation changes occur at close intervals. Tapti River and the Gawilgadh ridge of the Satpura Range forms the boundaries of the Reserve.The Flora of Melghat has been studied by various workers Witt (1916) and Patel (1968) studied mainly trees, shrubs and economic herbs etc. whereas Dhore and Joshi (1988) documented the floristic wealth of Melghat including herbs, grasses and cultivated species. Later on Bhogaonkar and Devarkar (1999) added 67 species and Londhe *et al*. (2002) reported 108 taxa to the existing list. Bhogaonkar and Dhole (2014) reported 02 new families to the flora of Melghat.

During the course of floristic studies in Melghat Tiger Reserve, the authors came across 02 new report of Fabacae members namely, *Flemingia macrophylla* (Willd.) O. Ktze. ex Merr. and *Paracalyx scariosus* (Roxb.) Ali, collected from Raipur and Dhakna ranges of Melghat forest. On perusal of the above literature, it is found that these species are not reported by earlier workers, so these two species found to be new distributional reports to the flora of Melghat.

Plants were collected, identified with the help of standard and regional floras (Hooker 1997, Cooke 1967, Naik 1998, Singh and Karthikeyan 2000, Yadav and Sardesai, 2002) and herbarium specimens made are deposited in the herbarium of BSI Pune.

Flemingia macrophylla (Willd.) O. Ktze. ex Merr. in Philipp. J. Sci. Bot. 5:130. 1910; Sanj. Legumes of India 176. 1991. *Crotalaria macrophylla* Willd. Sp. Pl. 3:982. 1802. *Flemingia congesta* Roxb. ex Ait. f. in Hort. Kew ed. 2, 4:349. 1812; Baker in Hook.f. Fl. Brit. India 2: 228. 1876; Cooke, Fl. Pres. Bombay 1:418. 1958 (Repr.). *F. nana* Roxb. Fl. Ind. 3: 339. 1832; Cooke, op. cit. 417. *F. congesta* var *latifolia* (Bth.) Baker in Hook.f. op. cit. 229. *F. congesta* var *nana*(Roxb.) Baker in Hook.f.op. cit. *Moghania nana* (Roxb.) Mukerjee in Bull. Bot Soc. Bengal 6: 20. 1953. *M. macrophylla* (Willd.) O. Ktze. Gen. Pl. l:199. 1891; Mukerjee, op. cit. 16.*'Chanagadda'.* (Fig. 1).

Fig.1: *Flemingia macrophylla* (Wild.) O. Ktze. ex Merr.

Fig. 2: *Paracalyx scariosus* (Roxb.) Ali

Shrubs, 1.8 m high. Leaflets 10–16 x 4–6 cm, elliptic–ovate, subcoriaceous, silky on nerves beneath, apex acute, lateral ones oblique at base; petiole winged. Flowers purplish–yellow, in dense, axillary racemes; calyx gland dotted, pilose. Pods oblong, rusty–tomentose.

Flowers and Fruits. : January–February.

Distribution : Nearby areas of Raipur village

Occurance: Rare

Additional specimen examined: INDIA, Maharashtra, Amravati (Raipur PAD 712, 14-01-2012).

Paracalyx scariosus (Roxb.) Ali in Univ. Studies Karachi 5 (3) : 95. 1968; Sanj Legumes of India 227. 1991. *Cylista scariosa* Roxb. Pl. Cor. 1: 64, t. 92. 1798; Baker in Hook.f. Fl. Brit. India 2 : 219. 1876; Cooke, Fl. Pres. Bombay 412.1958 (Repr.).*'Ran–ghevda'*.(Fig. 2)

Twiners, extensive; stems and branches woody, finely downy or tomentose. Leaflets 3.2–10.0 x 2–6 cm, terminal rhomboid, laterals obliquely ovate, velvety pubescent, apex acute, base rounded. Flowers yellow, in axillary peduncled racemes. Pods oblique, downy, 1–seeded.

Flowers and Fruits. *:*November–April.

Distribution: Dharni tehsil

Occurrence: Not common

Additional specimen examined: INDIA, Maharashtra, Amravati (Dhakna range PAD 717, 14-01-2012)

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RESEARCH REPORT

Ethno-Medico-Botanical observations on some wild tuberous plants of Kinwat Forest, Nanded

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ABSTRACT

An extensive survey of Kinwat forest during 2009-2010 related to wild tuberous medicinal plants was conducted. It has been observed that, wild tuberous plant species are in traditional use by local tribes to treat various human diseases. The present paper provides the medicinal uses of the few less-known wild tuberous plants.

Key words: Ethonobotany, Wild tuberous plants, medicinal use, Kinwat.

INTRODUCTION

Ethnobotany is a multidisciplinary science that deals with a direct relationship between man and his surrounding plants. The number of workers have been contribute (Upadhye *et al*., 1994 ; Gpoan and Bhadane, 2005; Deore ansd Somani, 2006 ; Patil and Ramaiah, 2006; Jain, 1990; Kirtikar and Basu, 1918; Jagtap, 2005; Gogte, 1982) to this field results in recording the ethnobotanical importance of plant species.

Kinwat is unique tribal taluka place located in South-East part of Nanded district of Marathwada region of Maharashtra. There are five communities of tribes inhabited in this region namely Andh, Gond, Pradhan, Naikda and Kolam. These peoples use various wild tuberous medicinal plants for their health problems. Tribes accommodate very close to the forest and have lot of knowledge about the medicinal plants of this region.

Kinwat region is rich in forest which makes a natural asset of immense value regarding medicinal plants. Kinwat forest comprises five different ranges which covers 73690.669 hectare area. The floristic survey of different ranges of Kinwat forest has been done earlier by various workers (Zate, 1983; Naik, 1998;

Chavan, 2002) to understand the floristic wealth of the region. Naik (1998) and Chavan (2002) explore certain plants of the area with short ethno-botanical notes . The large number of plant species including wild tuberous remain unexplored with regards to ethno-medicinal values. Therefore, ethno-medico-botanical observations on some wild tuberous plants of Kinwat forest has been undertaken.

The present paper focused on first hand information about the medicinal uses of the nine wild tuberous plant of the area. Several trips were undertaken during 2009-2010, in the different villages of the study region and collected plants were preserved in form of herbarium and some of them in standard preservatives in department of Botany Baliram Patil College, Kinwat Dist. Nanded. The collected plant species were identified with the help of floras (Cooke, 1967 ; Zate, 1983; Rothe, 1985; Almeida, 1990; Naik, 1998 and Yadav and Sardesai, 2002) and by Botanical Survey of India, Pune. The wild tuberous plant species are enumerated and arranged in alphabetical order which includes botanical name, family, local name and medicinal uses.

Enumeration:

1. *Amorphophallus campanulatus* Blume Araceae – Surkand.

It is rare in the forest. The local tribal medicine men planted it in their house gardens for its tuber. It grows in rainy season and later dries up but tuber lives under the soil for a long time.

Local use: The tuber is effective in cattle diseases. A disease locally called as 'Mandi' or 'Farya Rog' is caused by *Clostridium shovum.* A paste of tuber applied on the infected portion is found to be effective. In human being the small tablets of tuber are given to the patients for three weeks who are suffering from piles results are found to be good.

2. *Amorphophallus sylvaticus* Roxb. Araceae- Jangali suran/ Surnali

This is an important medicinal plant in Ayurveda occurs in the study region during rainy season only and later it dries up.

Local use: Corm and its prepared tablets used to relief the painful piles as well as to stomach pain.

3. *Ceropegia bulbosa* Roxb. Asclepiadaceae - Hanuman gadda

It is a twining perennial herb occurs under the bushes in hilly forest slopes in the study area.

Local use: Tubers of the plants are used as medicine. The tubers are sweet and used as an energetic tonic. The fresh pieces of the tubers are given to the patients who suffer from weakness due to long illness for 7 days and it is found to be positive effect.

4. *Chlorophytum tuberosum* Roxb Liliaceae - Pandhari musali.

It is an erect perennial herb occurs on hill slopes of the forest of study region. The roots of this plant are fibers slender ending with white, small ellipsoidal tubers.

Local use : The tubers are used as medicine. The powder of tuber or raw tuber is considered to be highly energetic as good as tonic.

5. *Corallocarpus epigaeus* Rottl. & Willd. Cucurbitaceae– Mirchikand

It is an important medicinal plant used in Ayurvedic medicine. It is climbing monoecious herb with tuberous roots. It occurs only in hill forest of the study region. The tuber is bitter in taste.

Local uses : The tubers are used as medicine in snake bite. Tubers eaten by snake bitten person, he feels sweet taste. Poison of snake remove through vomiting and too minimize be intensity of poison and ultimately helps to save the life.

Amorphophallus campanulatu

Ceropegia bulbosa Roxb.

Curcuma pseudomontana Grah

Dioscorea bulbifera L.

Tacca Leontopetaloides L.

Habenaria grandifloriformis

Fig. 1 Collected wild tuberous plants.

6. *Curcuma pseudomontana* Grah. Cat.- Zingiberaceae - Ran halad

It is a perennial herb of the study region occurs in forest. Its rhizome is used as medicine. It is found only in wild condition in the area. It is not cultivated in the area till today.

Local use: The rhizome is used as medicine. It is useful in hepatitis. The paste of rhizome given to the patient with cow milk three times in a day, for three days found to cure the disease.

7. *Dioscorea bulbifera* L. Dioscoreaceae- Nuska/Appagadda/Dukkar Kand.

It is a large perennial herb common in the forest of region. It has large tubers deep in the soil. It frequently occurs in different ranges of the forest.

Local use: The tubers are used as medicine. The paste of tubers applied on skin diseases and found to be effective and used as food in insufficient food condition.

8*. Habenaria grandifloriformis Blatt and Mc Cann*. Orchidaceae – Tinpani

It is a very beautiful orchid of the study area found in marshy hilly slopes during rainy season.

Local use : Tubers are used as medicine. Tribal medicine men believed that, the consumption oftubers increase the body strength.

9*. Tacca leontopetaloides*L. Taccaceae Jatashankar / penghagara

It is a perennial herb with white or brownish corms in the soil. It is endangered plant of this area having high medicinal value.

Local use : The tubers are used as medicine. It is used to cure cellulites and stomach pain. A small piece of corm with betel pan once in a day for seven days given to the patient and found to cure cellulites and also effective in psychiatric problems.

It is clear from the enumeration that, the wild tuberous plants of Kinwat forest play vital role in treating various ailments in tribal communities. It indicates the presence of important drugs in the plants. It is also observed that, these plants are rapidly vanishing and is cause of worry. Therefore it is an urgent need to make the inventory, protection and safe conservation of such important endangered plants of the area.

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