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A Dynamic Model of the Interaction of Biomass and Phytocenoses Resources in a Cyclic Change in External Influences and the Possibilities of its Use

By M V Zilberman & M V Cherepanov

Abstract- The results of studies are presented in the framework of an extended dynamic model that describes the interaction of the biomass of the ecological system and resources in a situation of cyclically changing levels of negative impact (seasonal changes), which are an integral feature of the existence of phytocenoses.

At the heart of this model is the perception that an environmental system is capable of accumulating the resources necessary for its own existence in the area of space in which the system is located. It is shown that in the conditions of cyclically repetitive changes in living conditions (seasonal changes), when the increase in biomass density occurs in the spring-summer period and is limited, and the increase in resource density occurs in the autumn-winter period due to the humification of the fall, this model is able to qualitatively display some typical cases of the evolution of phytocenoses.

Keywords: environmental system, biomass, resources, negative impact, dynamicmodel, seasonal changes.

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A Dynamic Model of the Interaction of Biomass and Phytocenoses Resources in a Cyclic Change in External Influences and the Possibilities of its Use

M V Zilberman [α] & M V Cherepanov [σ]

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At the heart of this model is the perception that an environmental system is capable of accumulating the resources necessary for its own existence in the area of space in which the system is located. It is shown that in the conditions of cyclically repetitive changes in living conditions (seasonal changes), when the increase in biomass density occurs in the spring-summer period and is limited, and the increase in resource density occurs in the autumn-winter period due to the humification of the fall, this model is able to qualitatively display some typical cases of the evolution of phytocenoses.

Solutions of the model equation system are presented, describing the accumulation of resources during biomass activities, the redistribution of power supplies between resources and biomass, and the loss of resources through abiotic processes that take into account how the system's sustainability and the degradation of the system in light of changing weather conditions.

It has been shown that the correlation between the parameters of the proposed model and the physically measured characteristics of phytocenoses is possible, at least theoretically.

Keywords: environmental system, biomass, resources, negative impact, dynamicmodel, seasonal changes.

I. Introduction

В настоящее время наблюдается возрастающее внимание к вопросам устойчивости экологических систем. Одним из свидетельств этого является Конвенция по климату [1] и ряд международных документов, приятых в целях ее развития (Киотский протокол, Парижское соглашение).

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Фитоценозы можно рассматривать как индикатор состояния окружающей среды [2].

К настоящему времени накоплен и систематизирован значительный объем фактических данных о состоянии природных объектов. Например, в [3] представлены сведения о первичной продуктивности экосистем Северной Евразии (территории бывшего СССР) более чем для 2500 пробных площадок, расположенных в различных природно-климатических зонах.

Современные технологии дистанционного зондирования Земли позволили накопить огромный и постоянно пополняющийся объем мультиспектральных снимков земной поверхности. Эти снимки позволяют вычислять вегетационные индексы, которые содержат весьма полезную информацию о растительном покрове [4].

Постоянно ведущиеся метеорологические наблюдения позволяют, с одной стороны, сопоставлять данные о растительном покрове с погодными условиями, а с другой – оценивать границы возможных изменений погодных условий.
В то же время, следует помнить о том, что современная методология исследования природных объектов во многом наследует те черты, которые сложились в период, когда основной целью исследований было определение ресурсного потенциала окружающей среды, а не ее охрана. В рамках этой методологии относительно просто решаются задачи обнаружения сходства и различия отдельных объектов, выделения отдельных групп объектов и т.п. Представления же об устойчивости природных объектов носят, в основном, качественный характер. В частности, считается, что экосистема может быть описана комплексной схемой положительных и отрицательных обратных связей, поддерживающих гомеостаз системы в некоторых пределах параметров окружающей среды [5].

При этом выделяют два типа гомеостаза: резистентный — способность экосистем сохранять структуру и функции при негативном внешнем воздействии и упругий — способность экосистемы

восстанавливать структуру и функции при утрате части компонентов экосистемы [6].

В предыдущей работе [7] нами была предложена динамическая модель экосистемы, учитывающая взаимодействие биомассы и ресурсов. Существо этой модели состояло в том, что изменение плотности биомассы определялось наличием ресурсов, которые биомасса использует для своего роста, а изменение плотности ресурсов – процессами накопления ресурсов в системе, обусловленными жизнедеятельностью биомассы, и абиотическими процессами потери ресурсов.

Модель представляла собой систему из двух дифференциальных уравнений, первое из которых описывало изменение плотности биомассы, а второе – плотности ресурсов. Анализ свойств этой модели показал, что все возможное множество состояний системы разбивается на два подмножества. Если начальные условия принадлежат первому подмножеству, решение асимптотически сходится к стационарному состоянию с ненулевой плотностью биомассы и ресурсов. Это подмножество было названо областью устойчивости. Если начальные условия принадлежат второму подмножеству, эволюция приводит систему к полной потере биомассы и ресурсов. Это подмножество было названо областью деградации.

Схематически эта ситуация представлена на Рис. 1.

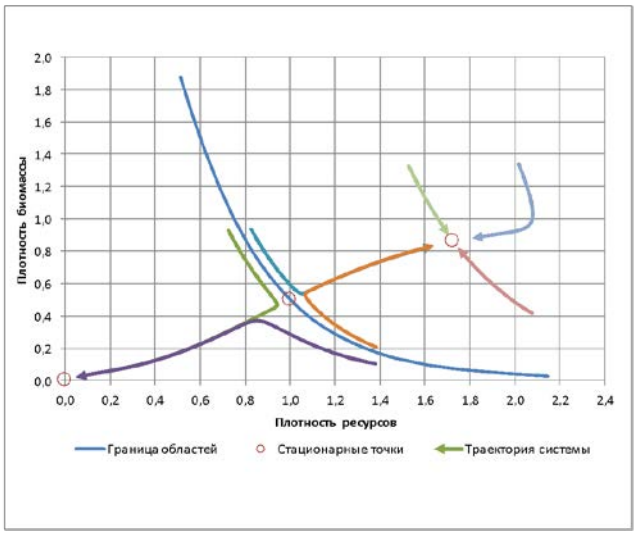

Рис. 1: Траектории эволюции системы

Положение границы, разделяющей эти подмножества, зависит от параметров, определяющих решение системы, к которым относятся скорости накопления и расходования ресурсов системой, уровень негативного воздействия и форма зависимости максимально достижимой плотности биомассы от плотности ресурсов.

В работе [3] параметры системы уравнений считались постоянными. В настоящей работе ранее разработанный подход распространен на случай циклически меняющегося уровня негативного воздействия (сезонных изменений), которые являются неотъемлемой чертой существования фитоценозов.

II. Модель

При разработке модели мы исходили из того, что объект моделирования (фитоценоз) находится в условиях циклически повторяющихся изменений условий существования (сезонных изменений).

Рост плотности биомассы происходит в весенне-летний период и носит ограниченный характер, а эти ограничения связаны как с наличием ресурсов, в частности, элементов питания, так и природно-климатическими особенностями. Поэтому для описания скорости изменения плотности биомассы использовали модификацию известного уравнения логистического роста [8]. При этом выражение, определяющее скорость изменения плотности биомассы, было сконструировано так, что для каждого сочетания плотности ресурсов и фактора воздействия имелось такое значение плотности биомассы, при котором скорость изменения биомассы равнялась нулю. Отметим, что это выражение можно рассматривать и как вариант традиционного представления продукции нетто-фотосинтеза, которая определяется как разность между приростом массы растения за счет ассимиляции углерода и его расходом за счет дыхания [9]

При описании скорости изменения плотности ресурсов учитывали три процесса. Первый процесс – это накопление ресурсов в ходе жизнедеятельности биомассы. Скорость этого процесса принята пропорциональной плотности биомассы. Второй процесс описывает перераспределение элементов питания между ресурсами и биомассой. Так, в весенне-летний период плотность ресурсов уменьшается за счет потребления этих ресурсов растущей биомассой, а в осенне-зимний период плотность ресурсов растет за счет гумификации опада. Скорость этого процесса принята пропорциональной скорости изменения плотности биомассы. Третий процесс описывает потерю ресурсов за счет абиотических процессов (вымывание элементов питания в подземные воды, водная и ветровая эрозия и т.д.). Скорость этого процесса принята равной плотности ресурсов.

С учетом сказанного уравнения модели представлены выражением (1)

$$\begin{cases} \frac{du}{dt} = \alpha \cdot u \cdot (g(t) \cdot f(v) - u) \\ \frac{dv}{dt} = \beta \cdot u - \delta \cdot u \cdot (g(t) \cdot f(v) - u) - \gamma \cdot v \end{cases} \quad (1)$$

где

u - относительная плотность биомассы

$g(t)$ - фактор воздействия

$f(v)$ - зависимость максимально достижимой плотности биомассы от плотности ресурсов

v - относительная плотность ресурсов

α - скорость роста биомассы

β - скорость накопления ресурсов за счет жизнедеятельности биомассы

δ - скорость взаимного превращения ресурсов и биомассы

γ - скорость потери ресурсов системы за счет абиотических процессов

По сравнению с работой [7] при описании скорости изменения плотности ресурсов в систему уравнений (1) добавлено выражение $\delta \cdot u \cdot (g(t) \cdot f(v), -u)$ которое обеспечивает более точное описание сезонной динамики содержания элементов минерального питания в почвах, но не влияет на стационарные решения, вычисленные для среднего по периоду значения фактора воздействия.

Плотности биомассы и ресурсов выражались в относительных единицах. Для определения относительной плотности биомассы использовалось выражение (2).

$$u = \frac{U}{U_{max}} \quad (2)$$

где

U - текущая плотность биомассы

U_{max} - максимально достижимая плотность биомассы при полном обеспечении ресурсами и наиболее благоприятных внешних условиях.

Для определения относительной плотности ресурсов использовали выражение (3)

$$v = \frac{V}{V_{0.5}} \quad (3)$$

Где

V - текущая плотность ресурсов

$V_{0.5}$ - плотность ресурсов, обеспечивающая плотность биомассы, равную половине максимально достижимой при наиболее благоприятных внешних условиях.

Как видно из выражения (1), аргументами, определяющими решение этой системы уравнений, являются две функциональные зависимости $g(t)$, $f(v)$ и четыре скалярные параметра. Рассмотрим эти аргументы более подробно.

Функциональная зависимость $g(t) \in 0,1$ характеризует влияние погодных условий на протекающие процессы. В настоящей работе считалось, что эта зависимость может содержать в себе две составляющие – детерминированную и случайную. В соответствии с этим положением моделирование зависимости $g(t)$ осуществлялось в следующем порядке.

Вычисляли вспомогательную функцию pt, которую представляли как сумму детерминированного и случайного процессов (4).

$$p(t) = p_{det}(t) + p_{stoh}(t) \quad (4)$$

где

$p_{det}(t)$ -детерминированная составляющая

$p_{stoh}(t)$ - случайная составляющая

Детерминированная составляющая обусловлена сменой времен года и по своему смыслу соответствует понятию «климатической нормы» которая,согласно [10] является «той или иной характеристикой климата, статистически полученной из многолетнего ряда, чаще всего средняя многолетняя величина». Исходя из такого определения, следует, что такая функция может быть представлена суммой периодических функций, например, рядом Фурье. На текущем этапе исследования для описания детерминированной составляющей использовали функцию (5).

$$p_{det}(t) = -cos(2 \cdot \pi \cdot t) \quad (5)$$

где

$t \in 0,1$ - доля периода (года)

Эта функция имеет минимальное значение в начале и конце периода и максимальное значение в его середине, что делает ее похожей на тенденцию изменения температур в течение года, характерную для умеренных широт северного полушария.

Случайную составляющую представляли как случайный процесс с нулевым средним значением, характеризуемый своей автокорреляционной функцией. В качестве автокорреляционной функции в настоящей работе использовали выражение (6)

$$K(\tau) = exp(-|\alpha \cdot \tau|) \quad (6)$$

где

α - коэффициент затухания

При моделировании случайного процесса использовали метод нерекуррентной фильтрации [11].

Для преобразования вспомогательной функции в интенсивность негативного воздействия использовали выражение (7).

$$g(t) = NormDistr(p(t), x_0, \sigma_p) \quad (7)$$

где

$NormDistr$- интегральная функция нормального распределения

x_0 - смещение

σ_p - дисперсия

Использование выражения (7) обеспечивало локализацию значений фактора негативного воздействия в интервале от 0 до 1. Вариация параметра x_0 позволяла варьировать среднее значение фактора воздействия, а вариация параметра σ_p – контраст значений фактора воздействия между «зимним» и «летним» периодами.

Функциональная зависимость $f(v)$ определяет плотность биомассы, для которой при заданном значении плотности ресурсов v и значении $g(t) = 1$ скорость изменения плотности биомассы равна нулю. Функция fv представляет собой монотонную невыпуклую гладкую функцию, меняющуюся в интервале от 0 до 1. В данной работе в качестве функции $f(v)$ использовалась интегральная функция логнормального распределения (8), удовлетворяющая всем вышеперечисленным требованиям.

$$f(v) = LogNorm(v, \mu, \sigma_v) \quad (8)$$

где

μ - логарифм медианы логнормального распределения

σ_v - дисперсия логнормального распределения

Отметим, что функция $f(v)$ по сути дела описывает реакцию биомассы на изменение плотности ресурсов, то есть типичную зависимость доза – эффект, и известны описания подобных зависимостей с применением логнормальной функции [12].

Параметры, α, β, γ и δ определяют скорости протекания отдельных процессов, учитываемых моделью. Смысл этих параметров и факторы, которые преимущественным образом их определяют, представлены в Табл. 1

Табл. 1: Физический смысл кинетических параметров и факторы, определяющие их значения

Параметр	Физический смысл	Факторы, определяющие значение параметра
α	Скорость роста биомассы в условиях отсутствия ограничений роста	Тип фитоценоза
β	Скорость накопления ресурсов за счет жизнедеятельности биомассы	Тип фитоценоза
δ	Скорость взаимного превращения ресурсов и биомассы	Тип фитоценоза
γ	Скорость потери ресурсов системы за счет абиотических процессов	Характеристики почвенного покрова (преимущественно гранулометрический состав и промывной режим)

Значения всех этих параметров являются безразмерными, то есть определяют скорости соответствующих процессов относительно периода детерминированной составляющей циклического изменения воздействия.

а) Свойства решений

В том случае, если фактор воздействия является постоянной величиной $g(t) \equiv g_0$, а зависимость $f(v)$ представлена логнормальным распределением, система (1) может иметь два стационарных решения с ненулевой плотностью биомассы и ресурсов. Значения плотностей биомассы и ресурсов, соответствующих этим состояниям определяются алгебраической системой уравнений (9) или уравнением (10), являющимся решением этой системы.

$$\begin{cases} g_0 \cdot f(v) - u = 0 \\ \beta \cdot u - \gamma \cdot v = 0 \end{cases} \quad (9)$$

$$f(v) = \frac{\gamma}{g_0 \cdot \beta} \cdot v \quad (10)$$

Отметим, что необходимое условие существования таких стационарных решений определяется неравенством (11).

$$max\left(\frac{f(v)}{v}\right) > \frac{\gamma}{g_0 \cdot \beta} \quad (11)$$

Как следует из выполненных модельных расчетов стационарное состояние, соответствующее большей плотности ресурсов, является устойчивым, а стационарное состояние, соответствующее меньшей плотности ресурсов – неустойчивым.

В соответствии со сказанным, можно предположить, что при циклическом изменении фактора воздействия фазовый портрет асимптотического решения системы (1) будет представлять собой замкнутую траекторию, расположенную вблизи устойчивого стационарного состояния, положение которого определяется выражением (10) при условии, что фактор воздействия в этом выражении (10) равен среднему значению фактора воздействия, то есть $g_0 = \overline{g(t)}$. Действительно, с формальной точки зрения при уменьшающейся амплитуде колебания фактора воздействия поведение решения должно приближаться к решению для постоянного значения фактора воздействия, то есть сходиться в

точку верхнего стационарного состояния, вычисленного для среднего значения фактора воздействия. Отметим, что с физической точки зрения замкнутая траектория фазового портрета характеризует состояние системы, в которой происходят периодические повторения изменения плотности биомассы и ресурсов.

Для проверки этого предположения нами были проведены модельные расчеты с целью поиска асимптотических решений системы уравнений (1).

При проведении этих расчетов предполагалось, что изменение фактора воздействия определяется только детерминированной составляющей. Поскольку значения плотностей биомассы и ресурсов, принадлежащие хотя бы одной точке асимптотического решения заранее не были известны, расчеты выполнялись в следующем порядке.

Для заданного сочетания параметров рассчитывались положения стационарных точек, соответствующих среднему значению фактора воздействия. В качестве начальных условий для плотности биомассы и ресурсов принимались значения этих величин в верхней стационарной точке. Проводился расчет плотностей биомассы и ресурсов за период времени, соответствующий времени цикла изменения фактора воздействия. Сравнивали значения плотностей биомассы и ресурсов в начале и конце периода. В том случае, если эти значения различались более чем на заданную величину, расчет повторяли, используя в качестве начальных условий значения плотностей биомассы и ресурсов, вычисленные для конца периода.

Результаты расчетов, выполненных для различных величин смещения, что повлекло за собой и различия средних значений фактора воздействия, представлены на Рис. 2.

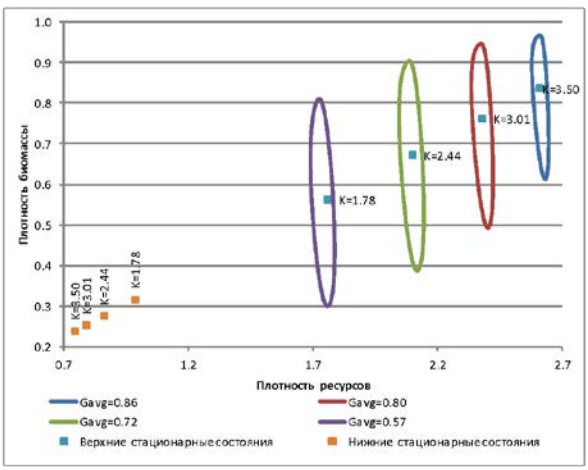

Рис. 2: Результаты расчетов, выполненных для различных величин смещения

Как видно из Рис. 2, центр траектории фазового портрета асимптотического решения во всех случаях остается вблизи верхней стационарной точки. По мере ухудшения условий существования фитоценоза (уменьшения среднего значения фактора воздействия g) наблюдается смещение асимптотического решения в направлении сокращения плотности биомассы и ресурсов. Одновременно происходит сближение точек, соответствующих верхнему и нижнему стационарному состоянию. Для оценки расстояния между этими точками использовалось отношение плотностей ресурсов в верхней и нижней стационарных точках (K), вычисленное для среднего значения фактора воздействия.

Учитывая тот факт, что нижняя стационарная точка принадлежит границе области устойчивости, отношение плотности ресурсов в верхней и нижней стационарных точках можно рассматривать как количественную меру удаленности асимптотического решения от границы области устойчивого существования фитоценоза.

В данной серии расчетов было обнаружено, что форма зависимости скорости изменения плотности биомассы от времени изменяется в зависимости от положения асимптотического решения относительно границы области устойчивости.

Результаты этих расчетов приведены на Рис. 3 в виде зависимостей скорости роста биомассы для вегетационного периода, то есть для периода, когда биомасса фитоценоза увеличивается. Отдельные кривые, изображенные на Рис. 3, относятся к разным значениям смещения.

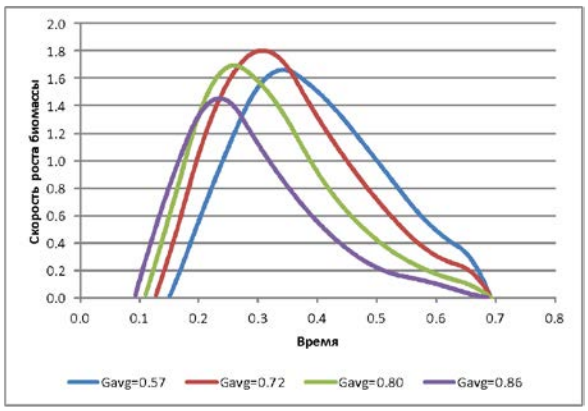

Рис. 3: Количественная мера удаленности асимптотического решения от границы области устойчивого существования фитоценоза

Как видно из Рис. 3 по мере улучшения условий существования фитоценоза для асимптотического решения наблюдается смещение начала периода роста биомассы в сторону

меньших значений времени и смещение пика скорости роста плотности биомассы, в этом же направлении. В качественном отношении форма кривых, изображенных на Рис. 3, весьма похожа на кривые суточной продуктивности фотосинтеза для растительных сообществ, определяемой в полевых условиях.

Решение системы уравнений (1) в том случае, если при моделировании учитывается случайная составляющая изменения фактора воздействия и начальное состояние системы близко к асимптотическому решению, приводит к фазовому портрету, представляющему собой спиралевидную кривую, расположенную вблизи от асимптотического решения, как это показано на Рис. 4.

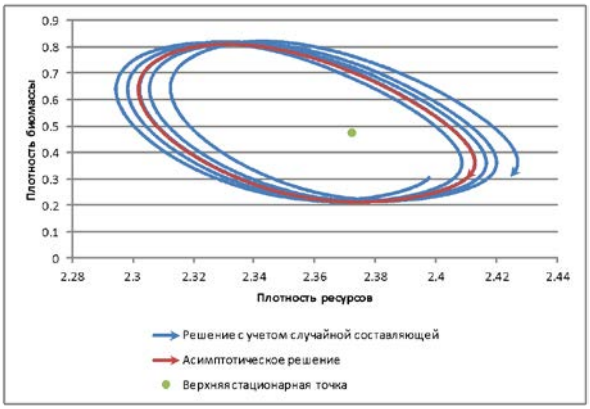

Рис. 4: Фазовый портрет решений при случайном изменении фактора воздействия при начальном состоянии системы, близком к асимптотическому.

Физическим аналогом решения, изображенного на Рис. 4, может быть луг, который в течение долгого времени не подвергался хозяйственному использованию, вследствие чего уровень обеспеченности почвы элементами питания стабилизировался на уровне баланса между процессами накопления питательных веществ за счет жизнедеятельности растений и расхода этих веществ за счет биотических процессов.

В том случае, если начальное состояние объекта далеко от асимптотического решения, например, зарастающая лесная вырубка, модель предсказывает приближение к асимптотическому решению, как это показано на Рис. 5.

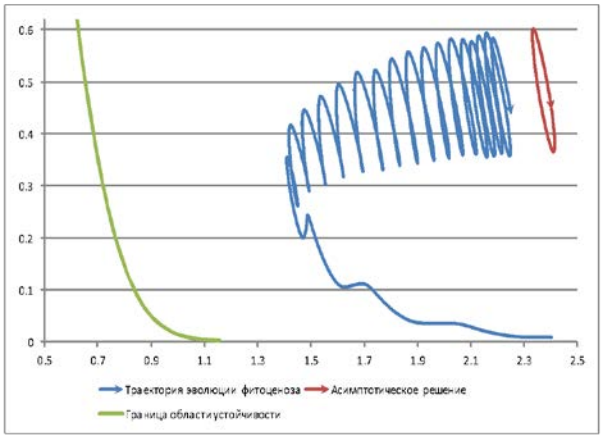

Рис. 5: Фазовый портрет решений при случайном изменении фактора воздействия при начальном состоянии системы, далеком от асимптотического

Характерной особенностью процесса, изображенного на Рис. 5, является то, что рост плотности биомассы на начальных этапах сопровождается уменьшением плотности ресурсов. В дальнейшем плотность ресурсов начинает возрастать, а состояние системы приближается к асимптотическому решению. При этом на этом начальном участке решения траектория системы проходит вдоль границы области устойчивости, а потом начинает удаляться от нее в сторону асимптотического решения.

b) К вопросу о калибровке модели

Из представленных данных следует, что система уравнений (1) может использоваться для описания разнообразных случаев поведения фитоценозов, в том числе и для прогнозирования их поведения при различных гипотезах об изменении фактора воздействия. При этом одновременно с прогнозом поведения системы могут быть получены сведения о том, насколько текущее состояние моделируемого объекта далеко от асимптотического решения и границы области устойчивости.

Однако, совершенно очевидно, что практическое применение этой модели возможно только в том случае, если известны значения параметров, входящих в состав предложенного математического описания, и имеется набор экспериментальных данных о состоянии исследуемого фитоценоза.

В настоящее время мы, к сожалению, можем только описать подход, который по нашему мнению может привести к оценке параметров, входящих в состав модели. Оценки параметров предложенной модели не могут быть получены из непосредственных измерений. Поэтому единственным путем получения таких оценок вариация этих параметров с целью минимизации различий между результатами расчетов и

экспериментальным оценками годичной и/или дневной продуктивности фитоценозов.

Несмотря на значительное количество параметров, подлежащих определению, эта задача не представляется более сложной, чем успешно решенная задача определения стехиометрических и кинетических коэффициентов в модели очистки сточных вод [13].

Определенную трудность представляет то, что внешние и внутренние факторы, определяющие решение системы (1) представлены в модели в виде обобщенных оценок gt и fv, соответственно, в то время как каждый из этих факторов представляет собой совокупность воздействий, различных по своей природе.

В частности, внешние факторы, обобщенные функцией gt в предложенной модели, по сути, совпадают с потенциальными пределами чистой первичной продукции, обусловленными физиологическими ограничениями по таким факторам как, солнечная радиация, водный баланс, температура и т.д.

Каждый из этих факторов может представлять собой либо монотонную зависимость, как, например, солнечная радиация, либо унимодальную зависимость, если существуют оптимальные значения фактора, как в случае температуры и условий увлажнения.

В обоих случаях есть возможность преобразовать интервал изменения реального воздействия в интервал значений от 0 до 1, который и является интервалом значений функции gt, определяющей уровень воздействия.

При этом, для преобразования физических значений параметра, оказывающего монотонное воздействие, необходимо иметь как минимум два параметра, один из которых определяет значение физического параметра, при котором наблюдается наиболее быстрое изменение формального параметра, а второй – определяет чувствительность формального параметра к изменению физического параметра.

Для представления унимодальных зависимостей необходимы как минимум четыре параметра, при этом первая пара должна соответствовать области, в которой физический параметр стимулирует жизнедеятельность фитоценоза, а вторая пара – области, в которой физический параметр угнетает эту жизнедеятельность.

Один из возможных способов такого преобразования для монотонной зависимости использован в настоящей работе в выражении (7).

Результатом решения системы (1) кроме плотности биомассы, которая может быть напрямую сопоставлена с оценками продуктивности фитоценоза, полученными в результате полевых исследований, или с использованием данных дистанционного зондирования Земли, является и плотность ресурсов, которая может быть сопоставлена с содержанием элементов питания в почве. Такие сопоставления могут проводиться на основе известных шкал обеспеченности растений элементами питания и представляются весьма полезными с точки зрения оценки соответствия модельных расчетов реальным характеристикам фитоценозов.

III. Заключение

Предложена динамическая модель, описывающая взаимодействие биомассы и ресурсов фитоценоза в условиях циклических негативных воздействий. Показано, что данная модель способна отобразить некоторые типичные случаи эволюции фитоценозов, по крайней мере, в качественном плане. При этом использование предложенной модели позволяет получить количественные оценки устойчивости фитоценоза как положение траектории эволюции системы относительно границы области устойчивости.

Показано, что установление корреляции между параметрами предложенной модели и физически измеряемыми характеристиками фитоценозов возможно, по крайней мере, теоретически.

Существенным является то, что данная модель является не только моделью роста биомассы, который описывается первым уравнением системы (1), но и, в определенном смысле, моделью процесса почвообразования, поскольку второе уравнение этой же системы описывает процессы накопления и расходования ресурсов в почве. Это обстоятельство, в сочетании с тем, что модель использует обобщенные оценки воздействия, определяемые погодными условиями, позволяет рассматривать эту модель как потенциальную платформу для объединения метеорологических данных, данных о продуктивности фитоценозов и результатов почвоведческих исследований.

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Toxicity of Mareb Crude Oil on Intertidal Clam *Tivela Ponderosa* and its Effect on Oxygen Consumption under Laboratory Conditions

By Aziz, S. Dobian & Hagib, H. Al-Hagibi
Sana'a University

Abstract- The impact of chronic exposure of Mareb Crude Oilon the rate of oxygen consumption of the clam, *Tivela Ponderosa* was studied in the laboratory. The bivalve *Tivela ponderosa* is exposed to (0.5, 1, and 1.5) ml/l of Mareb Crude Oil. The oxygen consumption of bivalves *Tivelaponderosa* was controlled hourly at 5th and 10th day (every two and six hours). After 5 and 10 days of exposure to crude oil concentrations, the average oxygen consumption in the clam after 5 days of exposure was (0.131, 0.135, 0.141, 0.319ml O_2 gm^{-1} dry tissue h^{-1} every two hours) and (0.121, 0.124, 0.137, 0.247 ml O_2 gm^{-1} dry tissue h^{-1} every six hours) and after 10 days it was (0.222, 0.561, 0.946, 1.117 ml O_2 gm^{-1} dry tissue h^{-1} every two hours) and(0.126, 0.432, 0.573, 0.632 ml O_2 gm^{-1} dry tissue h^{-1} every six hours). It was observed that the rate of oxygen consumption fluctuated with an increase in the exposure period. The increase in oxygen consumption in the treated clams can be explained by the high metabolic activity of the organisms due to the stress imposed by the pollutant. On the other hand, when increasing the exposure period for pollution substance decrease in oxygen consumption in the clams exposed to toxic substance concentrations. The possible reason for the latter is the insensitivity of the clams especially in high concentration of pollution substances.

Keywords: *toxicity, oxygen consumption, condition index, crude oil, clam tivelaponderosa.*

GJSFR-H Classification: *FOR Code: 059999p*

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I. Introduction

The rate of oxygen consumption varies with changes in the environmental and physiological conditions. Changes in physiological activities of organisms serve as an indicator of sublethal effects of pollutants on organisms (Sprague, 1971; Swedmark *et al.,* 1971; Hargrave and Newcombe, 1973). Thus, it is an indicator to determine the degree of stress caused by changes in the environment due to various natural and man-made perturbations.

Deshmukh (1979) studies the changes in oxygen consumption by the clam, *Meretrixmeretrix* exposed to various changes in natural conditions (temperature, salinity, etc.).Rate of oxygen consumption has been used as a valuable tool by many workers to assess stress, since it is an index of energy expenditure to meet the demands of environmental alterations (Prabhudeva and Menon, 1986; Mohan *et al.,*1986a,b). Most of the vital activities in bivalves are regulated by neuro-endocrine centers. The respiratory rate data of the animals reflect their general metabolic rate. The aim of this study by using bivalves (*Tivelaponderosa*) as bioindicator to determine the effect of toxic for Mareb Crude Oil on oxygen consumption rate in bivalve mollusks. In addition to study of the condition index of the exposed bivalve.

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II. Materials and Method

The bivalves were collected from Abyan Coast (12°. 48. 485 N, 45°. 02. 381 E) in Aden Governorate. They were collected by hand during the spring low tides in the evening times to avoid higher temperatures and were then kept in open canvas sacs containing wet sand to minimize frictions, desiccation and then transported to the laboratory immediately. They were protected from agitation during the transportation. The clams were cleaned by gentle rubbing in clean seawater to remove the clogged sediment and mucus and kept in aquaria of uniform size, 40cm long, 25cm wide 20 cm height, each containing clean and filtered seawater. Clams of uniform size of (47±1) mm long were used in the study to avoid susceptible size-based variations in response to the test chemicals. At the end of the acclimatization the experimental organisms for 4 days must be in excellent condition to tolerate the experimental conditions. There should be less than 2% mortality during acclimatization (APHA-AWWA-WPCF, 1976). Four clams from each of the control and from the exposed sets were transferred (five and ten days exposure to cured oil concentrations of 0.5, 0.1 and 5.1 ml/l into beakers of 500 ml capacity containing 400 ml filtered seawater. The water columns of the beakers were sealed with a 2.3 - 3 cm layer of inert liquid paraffin to prevent exchange of gas with atmosphere; following the method of Mathew and Menon (1983).

The oxygen consumption was determined for two and six hours in dark chambers to minimize the external stimulations. Then the oxygen contents were determined by Winkler's method for the experimental jars, the initial water and the control water without clams at the end of the experiment. After each experiment, the soft tissues were removed cleaned and dried at 80°C for 24 hours, and dry weights were determined. Standard

deviations were calculated based on 4 determinations in ml O_2 consumed per hour per gm dry weight.

A condition index relating dry tissue weight to shell length was calculated by:

$$\text{Condition index} = \frac{\text{Dry Weigh (gm)}}{\text{Shell length (mm)}} \times 100$$

The soft tissues were shucked off the shells, weighted then dried as above and reweighted to get the dry tissue weights. Then the dry-wet tissue weight ratio in percentage was calculated.

$$\text{Dry - Wet weight ratio} = \frac{\text{Dry Weight}}{\text{Wet weight}} \times 100$$

III. Results

a) Rate of Oxygen Consumption

Table 1.1 and Fig 1.1 illustrate the results of the rate of oxygen consumption of the control and Mareb Crude Oil exposed clams ml O_2/g dry soft tissues/hr for five and days (every two and six hours) of observation. Oxygen consumption in the control was 0.131 and 0.121ml/g dry weight/hr. The oxygen uptake increased gradually in clams exposed to different concentrations of the crude oil, in the low concentration 0.5 ml/l was 0.135 and 0.124 ml/g dry weight/hr, and the medium concentration 0.1 ml/l was 0.141 and 0.137 ml/g dry weight/hr, and the increase reached its peak in the clams exposed to high crude oil concentration 1.5 ml/l with an increase was 0.319 and 0.247 ml/g dry weight/hr, compare control during two and six hours respectively

The results of the rate of oxygen consumption of the control and test substance exposed clams ml O_2/g dry soft tissues/hr for ten days (every two and six hours) of observation. Oxygen consumption rate increased during the ten days compared oxygen consumption rate for five days. In the control was 0.222 and 0.126 ml/g dry weight/hr. During the low, medium and high concentration was {(0.561) (0.432)}, {(0.946) (0.573)}and{(1.117)(0.632)} ml/g dry weight/hr, respectively.

Fig. 1.1 and 1.2 show clearly the difference between the two groups of clams after 5 and 10 days exposure to Mareb Crude Oil toxicity (after two and six hours). The group in the Fig. 1.1 and 1.2 illustrate the rates of oxygen consumed by the control and the exposed clams after they have been transferred to crude oil-free seawater. In the 10 days group the rate of oxygen uptake was generally less than the rate of oxygen consumption in the 5 days group.

Finally, comparison of the charts after 5 and 10 days show clearly the difference between the two groups of clams after 5 days and two groups of clams after ten days of exposure to substance tests toxicity (after two and six hours). The charts illustrate the rates of oxygen consumed by the control and the exposed clams after they have been transferred to chemicals tests-free seawater.

Table 1.1: Average oxygen consumption (ml O_2 gm^{-1} dry tissue h^{-1}) in bivalves exposed to Mareb Crude Oil for five days (after 2 and 6 hours) values are mean ± for 2 determinations

Exposed (to ml/l)	Period of exposure (after two hours) Mean S.D	Period of exposure (after six hours) Mean S.D
0.0 (control)	0.131 ± 0.009	0.121 ± 0.015
0.5	0.135 ± 0.010	0.124 ± 0.070
1.0	0.141 ± 0.020	0.137 ± 0.014
1.5	0.319 ± 0.029	0.247 ± 0.003

Table 1.2: Average oxygen consumption (ml O2 gm-1 dry tissue h-1) in bivalves exposed to Mareb Crude Oil for ten days (after 2 and 6 hours) values are mean ± for 2 determinations

Exposed (to ml/l)	Period of exposure (after two hours) Mean S.D	Period of exposure (after six hours) Mean S.D
0.0 (control)	0.222 ± 0.011	0.126 ± 0.000
0.5	0.561 ± 0.033	0.432 ± 0.000
1.0	0.946 ± 0.000	0.573 ± 0.005
1.5	1.117 ± 0.025	0.632 ± 0.000

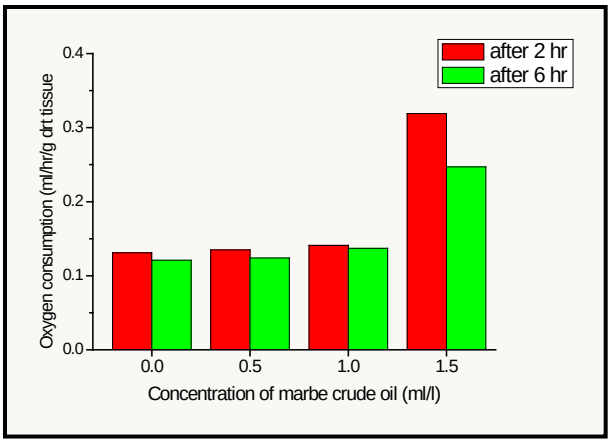

Fig. 1.1: Oxygen consumption by *Tivelaponderosa* after 5 days exposure to Mareb Crude Oil

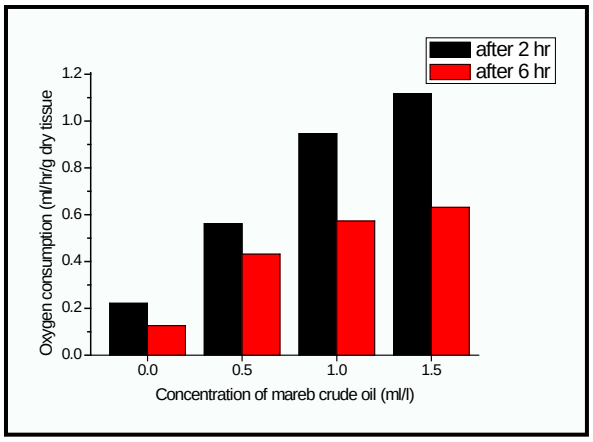

Fig. 1.2: Oxygen consumption by *Tivelaponderosa* after 10 day sexposure to Mareb Crude Oil

b) Condition Index

The observed values of condition index which is the ratio percentage between the dry weight (g) and shell length (mm) are given in Tables 2.1 and Fig. 2.1 which indicate a reduction in condition index of the clams exposed to Mareb Crude Oil for period of 5 and 10 days. The condition index of the control clams was 2.927 after 5 days and 2.751 after 10 days. Where decreasing condition index of the clams exposed to different concentrations Mareb Crude Oil during 5 and 10 days, in the low concentration 0.5 ml/l were 2.587and 2.446 ml/l, while the medium concentration 0.1 ml/l were 2.452, and 2.238 ml/l, the high concentration 1.5 ml/l were 2.396 and 2.198 ml/l.

c) Dry-Wet Weight Ratio

The data of the ratio between dry and wet weights of the control and exposed clams during 5 and 10 days are shown in tables 3.1 and Fig. 3.1. The decreased ratio was more or less inversely proportional to the degree for each test chemicals concentrations compared to the control. The ratio were 25.11 and 25.08 in the control and in the exposed clams to Crude oil compared to the control were {(24.34) (24.24), (22.89)(22.06) and (21.93) (21.12)}.

Table 2.1: Condition index as a function of Mareb Crude Oil concentrations for five and ten days

Concentrations (ml/l)	Condition index for *Tivelaponderosa*	
	concentrations for five days Mean S.D	concentrations for ten days Mean S.D
0.0 (control)	2.927 ± 0.134	2.751 ± 0.232
0.5	2.587 ± 0.326	2.446 ± 0.312
1.0	2.452 ± 0.289	2.238 ± 0.565
1.5	2.396 ± 0.182	2.198 ± 0.203

Table 3.1: Dry-wet weight ratio as a function of Mareb Crude Oil concentrations five and ten days. Values are means ± S.D, n =4

Concentrations (ml/l)	Condition index for *Tivelaponderosa*	
	concentrations for five days Mean S.D	concentrations for ten days Mean S.D
0.0 (control)	25.11 ± 0.44	25.08 ± 0.07
0.5	24.34 ± 0.36	24.24 ± 0.35
1.0	22.89 ± 0.06	22.06 ± 0.06
1.5	21.93 ± 0.44	21.12 ± 0.07

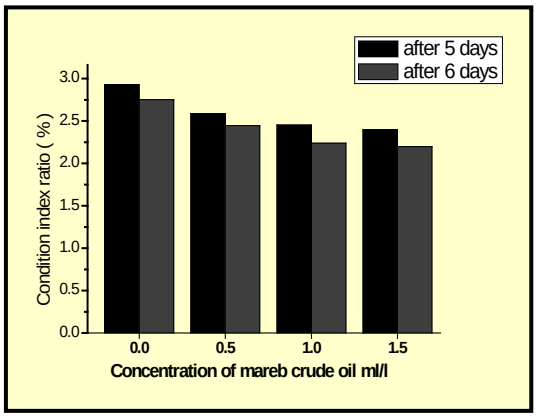

Fig. 2.1: Effect of Mareb Crude Oil concentrations on condition index of *Tivelaponderosa* after five and ten days exposure

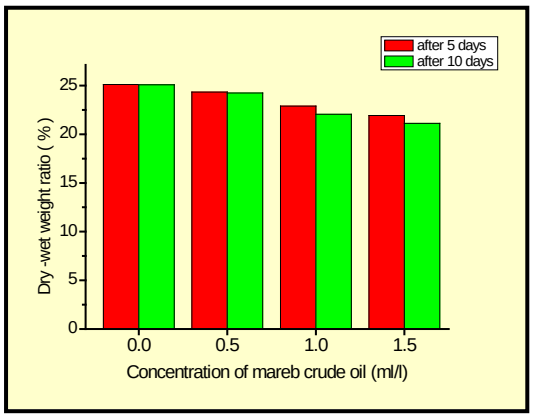

Fig. 3.1: Effect of Mareb Crude Oil concentrations on dry-wet weight ratio of *Tivelaponderosa* after after five and ten days exposure

IV. Discussion

a) Rate of Oxygen Consumption

The concept of assessing ventilation rate and O_2 consumption rate to explain toxicant stress arose out of the knowledge that metabolism and activity are interrelated. Variations in metabolic rate modify the scope for activity and the degree of activity affects metabolic rate. Usually, laboratory determinations of sublethal stress can delineate linear or nonlinear responses. The respiratory rate of aerobic organisms represents the metabolic activity and thus the oxygen consumption is a useful measure of sublethal effects on the animals which has been used to determine the extent of stress by various natural and man-made perturbations. The extent of modifications in oxygen consumption rate may be considered as great as pollutant-produced alterations (Anderson, 1977).

The present study showed a significant increase in oxygen consumption in the Mareb Crude Oil treated clams over that of the control clams. Oxygen consumption increased gradually with the increasing crude oil concentrations. The increase in oxygen consumption in the treated clams can be explained by the high metabolic activity of the organisms due to the stress imposed by the pollutant. The metabolic functions

demand energy and subsequently oxygen is needed for oxidation. It was observed by Percy (1977) that in animals exposed to seawater extracts of the oil, from which particulate oil had been removed, the metabolic rate was significantly stimulated; the degree of stimulation increased with increasing oil concentration. This leads one to explain the increase in oxygen consumption on the basis of oxygen utilization by the organism as due to demand for its high metabolic rate, which involves two distinct metabolic components; the basal metabolism reflects routine maintenance processes of the organism at rest and a further significant fraction of the oxygen demand is attributed to locomotion and other forms of activity (Newell, 1970).

The decline in oxygen consumption in the clams exposed to test crude oil concentrations during 10 days may be due in part, to the narcotization effect of the chemical on the animals and to the disturbance of the overall vital functions of the organisms by the compound. This condition can be attributed to the suppression effect of crude oil concentrations on the clams in addition to the effect of long term exposure. On the other hand, the decrease in oxygen consumption in case of the high hydrocarbon concentration is the result of activity reduction as Percy (1977) hypothetized this situation by stating that, the decrease in oxygen consumption is the result of activity reduction which may mask a general increase in basic metabolic rate.

Struhsakes *et al.* (1974) reported similar finding in fish exposed to benzene and showed that benzene penetrated readily into tissues and stimulated the respiration of fish; they opined that the increased respiration reflected a requirement for more oxygen to metabolize the benzene. Higher concentrations or extended exposure times resulted in a decline in metabolic rate and a possible narcotic effect arising from accumulation of benzene in the tissues.

Several workers reported the effects of hydrocarbons on the respiration of marine organisms but the result varies considerably and in some cases an increase of oxygen consumption is recorded while decrease in others. The variations in the consumption of oxygen may be due to the type of hydrocarbon or the method of preparations or the duration of exposure or due to the environmental conditions of the experiments (Hargrave and Newcomb, 1973; Thomas and Rice, 1979). Avolizi and Nuwayhid (1974) who recorded a depression in the respiratory rates of the bivalves, *Branchiodontes* and *Donax* exposed to light crude oil which showed reversal conditions when exposed to high concentrations of the oil.

The clam *Anadaragranosa* exposed to naphthalene for a short term (96 hrs) exhibiteda reduction in its oxygen consumption (Eapen, 1987). On the other hand, several authors recorded observations similar to those of the present study where low hydrocarbon concentrations increases oxygen consumption and the high concentration decreased the respiratory rates. This is in accordance with Anderson *et al.* (1974b) who recorded an increase in respiratory rates as a function of water soluble fraction (WSF) of No. 2 Fuel. Gilfillan (1975) reported an increase in metabolic rates when bivalves were exposed to low hydrocarbon concentrations and reduction of it when exposed to higher hydrocarbon concentrations. Similar results were obtained by Hargrave and Newcomb (1973); Percy (1977); Tatem (1977); Thomas and Rice (1979).

The clam *Myaarenaria* had doubled its oxygen consumption when exposed to lower oil concentrations and when they were exposed to greater oil concentration showed a depression in the oxygen consumption rate. Stainken (1977) and Neff (1979) stated that the respiratory rate of early and late zoeae and megalops of mud crab were increased by exposure to phenanthrene and naphthalene in which the former had a greater effect than the latter on respiratory rate.

The above mentioned finding by different authors indicates that the metabolic response to hydrocarbons is more complex than the simple unidirectional inhibition or stimulation suggested by some studies (Percy, 1977).

b) Condition Index

This study has shown that both the condition index and the ratio of dry-wet weight tissues in *Tivelaponderosa* were significantly altered by the exposure to Mareb Crude Oil. The condition index parameter is another tool to interpret the growth rate of the animal and the actual energy balance indicating protein, carbohydrate and lipid catabolism to counteract the stressful conditions of pollution. The present results showed a gradual decrease of condition index as the test chemicals concentrations increased.

This condition was also observed by other authors like Roesijidi and Anderson (1979) in *Macomainquinata* and Stekoll *et al*. (1980) in *Macomaballhica*. Both the studies related the decrease in condition index to the negative energy balance which indicates energy utilization rather than storage. Granby and Spliid(1995) recorded a highly significant negative correlation with PAH in the common mussel. According to Anderson (1979) the time factor is necessary in obtaining a good result in condition index.

c) Dry-Wet Weight Ratio

The dry-wet weight ration also showed significant variation from the control with the decrease in values corresponding to the increase in oil concentration. The faster decrease in the dry weight in relation to the wet tissue weight may be explained by the loss of dry weight for using their energy reserves due to oil exposure. This state probably occurred because of various factors such as decreasing in feeding accompanied by the increase in metabolic rate and

reduction in filtering rates. The present results are in agreement with the conclusion recorded by Sophia and Subramanian (1990) who studied the clam *Meretrixcasta* exposed to various Crude and fuel oils whereby they lost dry weight faster than wet weight. Stekoll *et al.,* (1980) reported similar results.

V. Conclusion

The present study showed a significant increase in oxygen consumption in the test substances treated clams over that of the control clams. Oxygen consumption increased gradually with the increasing test substances concentrations. The increase in oxygen consumption in the treated clams can be explained by the high metabolic activity of the organisms due to the stress imposed by the pollutant. On the other hand, when increasing the exposure period for Pollution substance decrease in oxygen consumption in the clams exposed to toxic substance concentrations. The possible reason for the latter is the insensitivity of the clams especially in high concentration of pollution substances.

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Assessment of Heavy Metals Concentration of Particulate Matters (PM) around Metal Recycling Industrial Areas in IFE, South-Western Nigeria

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Abstract- Assessment of heavy metals concentration of Particulate Matters (PM) was carried out around metal recycling areas of Ife, south-western Nigeria in other to provide information on the rate of contamination/pollution caused by the atmospheric PM particles from the iron and steel industries in the area. Twelve (12) particulate matter samples were collected, prepared, and analyzed using Inductively Coupled Plasma Atomic Emission Spectrometry (ICPAES) respectively. Interpretation of the analyzed results were carried out for their metal contents and environmental assessments.

Keywords: *contamination, enrichment, pollution, geochemical.*

GJSFR-H Classification: *FOR Code: 070599*

Strictly as per the compliance and regulations of:

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Abstract- Assessment of heavy metals concentration of Particulate Matters (PM) was carried out around metal recycling areas of Ife, south-western Nigeria in other to provide information on the rate of contamination/pollution caused by the atmospheric PM particles from the iron and steel industries in the area. Twelve (12) particulate matter samples were collected, prepared, and analyzed using Inductively Coupled Plasma Atomic Emission Spectrometry (ICPAES) respectively. Interpretation of the analyzed results were carried out for their metal contents and environmental assessments.

Elemental composition analyses carried out on the PM samples showed that the mean concentrations of the elements are Mo 0.2±0.1ppm, Cu 6.4±3.3ppm, Pb 35.3±44.3ppm, Zn 169.3±162.3ppm, Ni 1.97±1.22ppm, Co 0.2±0.1ppm, Mn 28.6±18.6ppm, V 0.4±0.08ppm, Sr 1.28±0.5ppm, Cr 6.4±3.3ppm and Ba 6.2±3.4ppm. For the PM suspended in the atmosphere around the area, Zinc has the highest concentration (471ppm) and mean value of 169.25. Further geochemical evaluation of the metals using Enrichment Factor, Contamination Factor, and Pollution Load Index, revealed the significant concentration of Zn and Pb in the PM samples from the study area while the other elements are minimal. The Contamination Factor calculated showed that Zn, Pb and Ba are the elements contaminating the suspended PM mostly. They show moderate contamination of the PM (2.0, 2.0, and 1.0 respectively). The Enrichment Factor calculated also showed significant enrichment of Pb and Zn in the PM samples analyzed (0-8 and 0-5 respectively). The Pollution Load Index (PLI) showed that atmosphere of the study area, where the PM is concentrated is not highly polluted (PLI<1) but highly contaminated.

Keywords: contamination, enrichment, pollution, geochemical.

I. Introduction

Heavy metals are any metallic chemical elements that have relatively high densities and are toxic or poisonous at low concentrations. They are metals and metalloids having a specific gravity that is five times that of water (Semhi *et al.,* 2010). Their toxicity causes an increasing degree of contamination and pollution to any matter. The natural sources of heavy metals in soils are being influenced by the parent materials, the chemical and physical soil properties, weathering, the metal speciation, and the climatic conditions. The mineral content of the parent materials is one of the most essential factors for the amount of trace metals present in the atmosphere as aerosols, (Burt *et al.,* 2003). This function leads to a negative effect on human health and on all living organisms.

Particulate Matter (PM) in the air includes a mixture of solids and liquid droplets. Some particles are emitted directly while others are formed in the atmosphere when other pollutants react. Particles come in a wide range of sizes. The particles of 2.5 micrometers (or less) in diameter are called 'fine' particles. Those between 2.5 and 10 microns (PM10) are called 'coarse' particle. Ten-micrometer particles are smaller than the width of a single human hair (Ole Raaschou-Nielsen et al. 2013).

Atmospheric Particulate Matter plays an important, but detrimental, role in everyday life and influences several atmospheric processes (Othmar, 1996). PM typically comprises a complex mixture of different elements and compounds (Dallarosa*et al*., 2008). Dust containing heavy metals is dispersed globally by atmospheric circulation and becomes a minor but potent component of sediment, soils, and the hydrosphere with a major impact on Earth ecosystems (Petrovský and Ellwood, 1999). Heavy metals can be readily detected to frame policies for reducing emissions and monitoring their long-term effectiveness (Xia et al., 2008;Sagnottiet*et al*., 2009). The methods for monitoring emissions of PM are multidisciplinary which include geochemical, mineralogical, and microstructural. PM is emitted both from natural and artificial sources (Choi et al., 2001; Fang et al., 2002; Zhang et al., 2010b) which has brought a challenge into investigations on how to separate contributions from the two primary causes. In urban areas the diversity of possible anthropogenic emissions renders source assignation difficult (Choi *et al.,* 2001; Kim *et al*., 2008; Zhang *et al.,* 2012b). Although many investigations show that geochemical methods are useful for detecting PM sources (Wang et al., 2005: Kim *et al.,* 2007).

II. Methodology

Materials used for field sampling include the vacuum sampler, generator, filter papers, Global Positioning System (GPS), stepdown transformer, field boots and notebooks, measurable foils, sample bags, elbow-length gloves, e.t.c. The field research took place in November, which is the tail end month of the rainy

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season at Ife axis. Hence, the effects of rain affecting the collection of particulate dust samples were reduced. The sample locations were concentrated mainly on Iron and steel industries.

Collection of the PM samples was done with the aid of a filter paper and a vacuum sampler. The sampler was placed 200m away before and after each industry. Because the exhausts of the industries are placed high above the ground, the sampler was left for four hours to allow the suspended PM dust particles coming out from the industrial exhaust to settle on the filter paper. After four hours, the sampler was switched off, and the filter was immediately removed from the supporting screen, folded and then placed in a measurable foil. The vacuum sampler was moved to other locations still within the environment of the industries of concentration. A total of 27 particulate dust samples were collected on the filter papers out of which the best 12 were selected and analyzed for elemental constituents.

III. Results and Discussion

The results of the analysis for the PM samples revealed varying concentrations for different trace metals in the sampled medium employed in the study. The identified trace element content of the analyzed particulate matter dust samples include Cr, Cu, Pb, Zn, Ba, Co, Mn, V, Sr, Mo, and Ni.

From the descriptive statistical table (Table 1), it was observed that the zinc concentration (471ppm) suspended in the PM of the atmosphere in one of the industries of study area is high when compared with the Average Shale Content (ASC) of Zn (90), and the PM concentrates of Lagos lagoon which has a range concentrate of 4.7-47.5ppm (Popoola et al., 2014). The high concentration of Zn displayed can be said to be due to Zn usage in galvanizing iron, thereby forming particulate matter with the geogenic atmospheric particles present in the area. The peak concentration of lead (160ppm) suspended in the PM of the atmosphere in one of the industries of the study area is also high when compared with the ASC of Pb (20) and the Pb concentration of Warri PM which is 1.02ppm (Okuo et al., 2006). The copper concentrates present in the particulate matter (with the highest quantity of 11ppm) are insignificant when compared to the Average Shale Content (ASC) of Cu (50). They are still higher than the Cu concentrates of Ikeja town which has a concentration of 1.36ppm (Oluyemi and Asubiojo., 2001). The highest quantity of Mn in the particulate matter samples is 60ppm, and this is insignificant when compared with the ASC of Mn (850ppm) but is also higher than the concentrates of Warri and Lagos which have concentrations of 0.01ppm and 5.0-20.0ppm respectively (Popoola *et al*., 2014, Okuo *et al*., 2006).

The concentrations of Cobalt (Co), Chromium (Cr), Molybdenum (Mo), Vanadium (V), Strontium (Sr) and Nickel (Ni)are lesser than their various ASC in the particulate matter samples. This indicates little or no significance of the distribution of these metals in the study area.

Table 1: Summary Table for Particulate Matter Metal

Concentration

Factor Analysis

The Factor Analysis was used for data reduction of the number of variables into one of considerably fewer linear combinations variables that account for the proportion of the total data variance and which can often be more readily related to recognizable geological and environmental processes than the input variables themselves (Olatunji and Olisa, 2014). Factor analysis finds a suitable application in geochemical interpretation, and it can be used to identify the source of contamination.

In the Particulate Matter (PM) particles, 11 elements (Cu, Mo, Zn, Pb, Ni, Mn, Co, V, Sr, Cr, Ba) were placed on R-mode factor analysis; the computation was done using SPSS computer software package. Identification of three components was done from the factor analysis, and these accounted for 95.15% in the suspended dust particulate samples (Table 3).

Factor 1: Cu, Mo, Zn, Ni, Co, Sr, Cr, Ba accounted for 55.84% of the total variance of the three components present in the dust particles. These can be said to be derived mainly from atmospheric deposition forming PM deposits from alloying materials; vehicular emissions; incineration of waste dumps.

Factor 2: Pb, Mn, V, Sr accounted for 29.05% of the total variance of components present in the dust particles. These can be said to be derived from the extraction of metals, vehicular emissions, wear and tear of old vehicle parts and combustion of fuels which forms has PM particles in the atmosphere.

Factor 3: Zn and Co accounted for 10.26% of the total variance of components present in the dust particles. It is derived from the electroplating emissions, and emissions from metal refuse in the industries which also form PM with the already present natural atmospheric particles.

Environmental Assessment

Enrichment Factor (EF), Contamination Factor (CF), and Pollution Load Index (PLI) were used to assess the quality of the study area.

Enrichment Factor

The Enrichment Factor (EF) classification (Table 4) was used to evaluate the status of environmental enrichment of metals present as PM in the area.

Table 4: Enrichment Factor Classification(Simex and Helz, 1981)

For the PM samples, the calculated enrichment factor (Table 5) shows that only Pb and Zn have moderate to significant enrichment (0-8 and 0-5 respectively) and this could be due to the gaseous emissions (smelting of recycled lead and galvanizing process) that are released from the factories.

Table 5 Summary Table for Enrichment Factor of Particulate Matter Samples

Contamination Factor

The level of contaminations of heavy metals in the PM samples analysed was determined using the contamination factor calculation. It is shown as;

Contamination Factor = Mean concentration/ background value of metal (Hakanson *et al*.,1980)

The classification table (table 6) showed that Sr, Co, Ni, Cr, Mo, V, Mn, and Cu are not forming any form of contamination with the atmosphere of the area while Ba, Pb, and Zn have moderately contaminated the atmosphere of the study area with a CF of 1, 2 and 2 respectively (table 7)

Table 6 Contamination Factor Classification

Table 7 Summary Table of Contamination Factor for Particulate Matter Samples

Pollution Load Index (PLI)

PLI was used to measure the pollution status of the study area. The composite PM samples were analyzed, and the quality is measured using the Contamination Factor, and the number of heavy metals studied. The equation for PLI is shown as;

PLI = (CF1*CF2*…*CFn) 1/n, where n is the number ofmetals and CF is the Contamination Factor of PM samples.

Table 8 Pollution Load Index Classification

Using the PLI classification (Table 8), it is shown that individual PM samples shows no pollution in the area of study, consequently the atmosphere has not attained a noticeable status of pollution (calculated PLI=0).

IV. Conclusion And Recommendation

Metal concentration and distribution in Particulate Matters (PM) of Ife metal recycling industrial area using various environmental assessment revealed different levels of contamination in the dust samples analyzed. The assessed evaluation revealed that Pb and Zn are the most enriched in the PM and are also the major causes of contamination in the study area and their principal source is from the metal-laden PM generated in the area. The industries are agents of high contamination to the $_{154}$ atmosphere of the study area and are also enriching the already present geogenic heavy metal composition of the environment.

Although, PLI shows zero (0) indicating no pollution of the atmosphere, increasing urbanization and industrial activities will increase the contamination rate, thereby leading to pollution. The enrichment and contamination of metals, especially Pb and Zn, (through particulate matters) occurring in the study area are enough factor to check the daily activities of these iron and steel industries. Consequently, greater environmental awareness is needed to develop ways to reduce environmental contamination of the study area. The industries and buildings in the study area should have a greater distance in between them. This will reduce the effect of the industrial activities on the habitants and their environments

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Evaluation of Birds Species Abundance and Diversity in Borgu Sector of Kainji Lake National Park, Nigeria

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Abstract- The study focused on bird's species abundance and diversity in Borgu sector of Kainji Lake National park Nigeria. Line transects were established in the collection of data on bird's species. Data collected were subjected to descriptive statistics (frequencies tables and percentages) as well as Simpson diversity index. The result on the checklist of birds obtained showed that there were 166 species belonging to 28 families. Results of the relative abundance of bird's species showed that *Bubulcus ibis* (77.88) and *Ictinaetusmalayensis* (0.29) had the highest and lowest relative abundance respectively. The result of the Simpson diversity index (0.939) of bird species by families showed that Ardeidae (593) and family Sturnidae (392) had the highest and lowest number of bird's species respectively. Environmental education (conservation, production and enrichment) campaign should be carried out on the status of birds and other components of the ecosystem to boost the tourism potentials of the park.

Keywords: *birds' species, list, abundance, diversity.*

GJSFR-H Classification: *FOR Code: 050211, 820199*

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Evaluation of Birds Species Abundance and Diversity in Borgu Sector of Kainji Lake National Park, Nigeria

Kwaga, B.T. [α], Suleiman, J.M. [σ], Ringin, M.I.G. [ρ] & Khobe, D [ω]

Abstract- The study focused on bird's species abundance and diversity in Borgu sector of Kainji Lake National park Nigeria. Line transects were established in the collection of data on bird's species. Data collected were subjected to descriptive statistics (frequencies tables and percentages) as well as Simpson diversity index. The result on the checklist of birds obtained showed that there were 166 species belonging to 28 families. Results of the relative abundance of bird's species showed that *Bubulcus ibis* (77.88) and *Ictinaetusmalayensis* (0.29) had the highest and lowest relative abundance respectively. The result of the Simpson diversity index (0.939) of bird species by families showed that Ardeidae (593) and family Sturnidae (392) had the highest and lowest number of bird's species respectively. Environmental education (conservation, production and enrichment) campaign should be carried out on the status of birds and other components of the ecosystem to boost the tourism potentials of the park.

Keywords: birds' species, list, abundance, diversity.

I. Introduction

Quantifying the species abundance of birds communities has gained increasing importance in environmental impact assessment especially in conservation planning and ecological research (Bibby *et al.,*(2000).Species inventories not only help in understanding species losses but also help determine the characteristics of species that are vulnerable to habitat perturbations (Koh *et al,.* 2004).The species richness is simply the total number of species within a habitat or community. Species richness is the most commonly used measure of diversity because it is a straightforward measure and it is intuitive. The main problem with using species richness is that it does not provide any information on how well each of the species is represented in the sampled area. Species diversity is a measure of both the number of species (species richness) and the relative contribution of each of these species to the total number of individuals in a community (evenness) (Stiling, 2002). Birds are warm blooded; they have been able to adapt themselves to living in climates varying from the ice snow of the Antarctic to the fringes of the hottest deserts.

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Diversity has been referred to as the quantitative measure that reflects how many different species are in existence in a data set. A variety of objective measures have been created in order to measure of diversity. The basic idea is to obtain a quantitative estimate of biological variability that can be used to compare biological entities, composed of direct components, in space or time (Albert, 2012; Magurran, 2004).

Monitoring of species is therefore important in determining conservation actions if set plans to be effective in achieving population objectives that for increasing populations to reach target levels. Assessment of birds' species richness and abundance of an area makes it possible for any organization to plan for future conservation and sustainable utilization of avifauna resources (Bird Life International BLI-2008). Hence, the need for this study which is aimed at evaluation of birds species richness and diversity in Borgu Sector of Kainji Lake National Park, Nigeria.

II. Methodology

a) Location of the Study Area

Kainji Lake National Park is situated in Niger State located between latitudes 8°00'N and 11°00'N, and longitudes 4°00'E and 11°30'E. The study area Borgu sector is located between latitudes 7°00'N and 9°45'N, and longitude 4°30'E and 8°30'N (Ayeni *et al.,* 2007).The park lies only 560km North of Lagos and 385km to the northwest of the Abuja, the Federal Capital of Nigeria. The park covers a total land area of 5340.82km^2. It is made up of two non-contiguous sectors (Borgu and Zugurma). The Borgu sector lies astride the Borgu and Baruten local government areas of Niger and Kwara states, with an area of 3,970.02km^2. Zugurrna sector on the other hand, occupies a relatively smaller area of 1,370.80km^2 situated in the Mariga local government area of Niger State (Ezealor, 2002).

The wet seasons extends from May to October while the dry season extend from November to April. The mean annual rainfall of the Borgu sector varies from 1,100mm in the eastern part to 1,150mm in the Western part. The rainfall data for Zugurma sector shows that the sector receives a mean annual rainfall of about 1,167mm.Rain generally lasts for 8 to 9 months of the

year. It starts in March and ending in October or November (Ezealor, 2002).

Temperature is highest in the dry season and lowest during the wet season. Temperatures pick up again towards the end of the wet season and later drop to the lowest value in December and January during the harmattan. Temperature at 9hour and 12 hours are higher than at 15 hour and 18 hours. Mean daily maxima are greatest during February and march with values of about 37°C while the lowest values of about 30°C occur during the height of the harmattan that is December and February (Ezealor, 2002).

The relative humidity appears to increase gradually from low values (less than 20%) at the beginning of thedry season to a peak during the wet season (96%). A transitional period ofvariable conditions occurs at the end of both the dry and the wetseason; it is characterized by strong easterly winds, which are associated with line squalls. The highest' wind speed usually occurs in April with values of 6.21 - 6.39 km/hr while the lowest speed of 2.23-2.28 km/hr occurs in October (Ezealor, 2002).

The major vegetation type of the Kainji lake National park is typically Northern Guinea Savanna Ecotype. Ayodele, (1988) also identified over seven vegetation sub-types for the park. These are; *Burkia Africana / Detariu,* wood land, *Afzelia africana* wood land, *Isoberlinia tomentosa* wood land, *Terminalia macroptera* wood land, *Diospyros mespiliformis woodland,* Acacia complex, Oli complex and Riparian forest among others.

Some of the fauna species found in the park includes; Roan antelope, *Hippotamus hippopotamus amphibius,Hippotragus equines, Kob Kobus kob,* Serval *cat Felis serval,* Ratel, Honey badger *Mellivoracapensis, Hare Lepus capensis,* Green *Monkey Cercopithecus aethiops.* African *Mrulatee Trichechus senegalensis,* Lizard buzzard *Kaupifalco monogrammnieus. Avifauna* species;cattle egret *Bululcus ibis,* Grey heron *Ardea cinerea,*Little egret *Egreta gazetta,* African grey hornbill *Tockus nasutus,* Little paradise kinfisher *Tanysuptera hydrocharis,* Helmete guineafowl *Numida meleagris,* stone patridge *Ptilopachus petrosus,* White throated bee eater *Merups allibicolis,* Abysinian roller *Corasins absinnicus,* Mourning dove *Zenaida macroula,* Laughing dove *Stigmatopelia Senegalensis,* Black froncolin *Francolinus francolinus,* Red eyed dove *Streptopelia semiquata,* Black billed wearer *Ploceus melanogoaster,* Hadada Ibis *Bostrychia hagedash.* Reptilian species crocodile *Crocodilus niloticus,* aligator, monitor lizard etc. (Ayodele, 1988).

III. Study Design and Data Collection Techniques

The entire study area was classified into five (5) woodland associations (site 1 *Burkia/Detarium macrocarpum* woodlands, site 2 *Afzelia Africana* woodlands, site 3 *Acacia* complex, site 4 *Isoberlinia tomentosa* woodlands and site 5 *Riparian* forest) based on the existing species. A 4km length of transects were established in each association. In each of the five sections and along each transects, observations (on calls, feathers, sounds) were carried out between the hours of 6.00am to 10.00 am (morning section) and 4.00 pm to 6.00 pm (evening section) following Akosim *et al.,* (2007), Nik and Ron (2008) and Kwaga *et al*, (2017) guides. The materials used include: Bird field guide books (Bibby *et al.,* 2000; Khobe and Kwaga, 2017) and a pair of binocular, recording sheet and a pen.

Direct (sighting by use of binocular) and indirect (indicators eg. Feathers, calls, sounds) methods as well as group/composition and number of birds identified were recorded. Methods of bird census were employed in the identification of bird species in the area. Interaction was also entertained for more identification of the species. 5 transects of 4km in length were established using a stratified random sampling procedure (Plumptre &Reynolds, 1994). Line transects were chosen as sampling units due to the open nature of much of the area following Bibby *et al., (*2000) and Khobe and Kwaga (2017) guides.

The observer walking along transects and, on sighting bird's species waits for a few minutes to allow the disturbed birds to settle. Counting was carried out for ten (10) minutes individual bird was counted once and all birds Seen or heard out-side the band but was identified was recorded, Birds, Indices, Feathers, calls were also recorded. Species composition of birds observed was recorded along the 4km transect in each of the five sections following Eshiamwata (2007), Nik and Ron (2008) and Kwaga*et al.,* (2017) guides.

IV. Statistical Analysis of Data

a) Birds Species List and Abundance

Data collected on species list and abundance were analyzed using descriptive statistics(frequencies table, percentages).

b) Diversity of bird species

Data on bird's species diversity was analyzed using Simpson's diversity index as adopted by Akosim *et al.*, (2007) and Khobe and Kwaga (2017).The index is mathematically stated thus;

$$D = 1 - \left(\frac{\sum n(n-1)}{N(N-1)}\right)$$

D, = Simpson's diversity index, n, = Total number of organisms of each individual species
N = Total number of organisms of all species, s = Number of species present
$\sum$ =Summation sign.

V. Results

The result of checklist of birds species in the study area is presented in Table 1. The result showed that*Tanysiptera hydrocharis*, *Ceyx pictus Egretta garzetta, Bubulcus ibis, Coracias abyssinicus, Centropus senegalensis, Merops albicollis, Numida meleagris, Ptilopachus petrosus, Francolinus francolinus, Batis mixta, Ploceus melanogaster, Pulsatrix koeniswaldiana, Lamptrotormis purpureus, Lamptrotormis chalybaeus, Lamptrotormis chloropterus, Lamptrotormis splendidus, Bostrychia hagedash, Anthracothorax veraguensis, Sayormis nigricans* and *Mitrephanes phaeocerus* were available in the study area.

a) Species Relative Abundance

The result of bird species relative abundance in the study area is shown in Table 2. The result showed that the highest relative abundance is in Site 2 (101.51%) followed by site 3 (100.01%) and site 1 being the lowest (99.95%) respectively.

The result also showed that *Bibulcus ibis* is the highest (77.88%) followed by *Numida meleagris* (51.87%), *Sayornis nigricans*(26.41%), *Batis mixta*, *Ploceus melonagaster* and *Lamprotornis purpureus* species had thesame relative abundances in across the sites with 22.56%, 22.56% and 22.56%. *Apus apus* had the lowest(22.52%), while the least is *Ictinaceous malayensis* (0.29%) in the study area.

b) Birds Diversity

Result of bird species diversity in the study area is presented in Table 3. The result showed the species diversity of D=0.939, respectively.

VI. Discussions

a) Checklist of Birds Species in the Study Area

The findings of this study suggested few species list of birds. This is not in agreement with the reports of Sodhi *et al.,*(2005) who identified 61 species in similar studies and BLI (2008) who recorded over 180 species. However, this isin conformity with Nason (1992) who reported that throughout the world, there are over 9000 species of birds of which Nigeria has approximately 840 species.

b) Birds Species Relative Abundance in the Study Area.

The findings on birds species relative abundance in all the sites sampled is very low. However, the findings also shows the relative abundance of birds species utilizing the study area, it shows that total relative abundance of *Bubulcus ibis* is higher followed by *Numida meleagris, Sayornis nigricans*, *Apus apus*, *Bats mixta*, *Ploceus melanogaster* and *Lamprotornis purpureus*. The high relative abundance may not be unconnected with availability of food, water, breeding sites which are supported by various authors. Khobe and Kwaga (2017) reported that the level of distribution of bird species in a habitat is normally as a result of an occurrence of plant species that support their population and to variation in species specification requirements in the choice of habitat. This finding is also in agreement with Kwaga *et al.*, (2017) that the distribution of birds' species is largely dependent on the availability of food, water and cover.

Stiling (2002) asserted that monitoring of birds species is therefore important in determining if conservation actions resulting from set plans are effective in achieving populations objectives. Heagy and McCracken (2004) observed that through continuous monitoring, the Ontario Eastern Bluebirds in North America formally considered threatened in the area but as a result of net box programs and other conservation actions, the bluebird's population has made a dramatic comeback and it is no longer considered to be at risk.

c) Birds Species Diversity in the Study Area

The diversity of bird species in the study area shows D=0.939. This indicate that there is high bird's species diversity in the area, the findings signifies that there is no significant difference (P>0.05) between the ranges in bird species composition in the study area.

The high bird species diversity in the Kainji Lake National Park (KLNP) in relation to habitat characteristics is very encouraging, meaning that they do breed well in the area most especially the *Bubulcus ibis* and *Numida meleagris* whose population is on a high side. The causes of this high diversity of birds could be as a result of available ecological requirements in the study area. This is in contrast with Eshiamwata (2007) who asserted that the causes of bird populations declined includes natural system modification, biological resource use, climate change and severe weather. BLI, (2008) also confirmed that many birds species are sensitive to toxic chemicals, and therefore are bio-sentinels. The birds' species are highly mobile, and will either desert habitats that no longer meet their environmental needs or colonize habitats that have been altered and now satisfy their needs. The high diversity indicates that most of the birds are indigenous species; they have been able to adapt themselves to living in the area. This is in agreement with Stiling (2002) who asserted that birds are warm blooded, they have being able to adapt themselves to living in climates varying from the ice snow of the Antartic to the fringes of the hottest deserts.

VII. Conclusion

From the findings of the study, it suggests that the bird species list and abundance (total number) in Borgu Sector of Kainji Lake National Park (KLNP) habitat is low. This shows that relatively few successful species such as the family Ardeidae, followed by Numidae still exist in KLNP habitat in low number. It also indicates that the KLNP environment is quite stressful with relatively few ecological niches, where only a few birds' species

are really adapted to that environment. Also the low population number could be as a result of toxic chemicals birds used during farming activities by the communities around the park. It is therefore imperative to ensure that proper conservation and management of species habitat is enhanced for bird species sustainability in Kainji Lake National Park.

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Table 1: Checklist of Bird Species in the Study Area

S/N	Family name	Common name	Scientific name	Authority	Site 1	Site 2	Site 3	Site 4	Site 5
1	Accipitridae	African Harrier-hawk	*Polyboroides typus*	(Smith, 1829)	-	-	+	+	-
2	Accipitridae	Black Eagle	*Ictinaetus malayensis*	(Temminck, 1822)	-	-	+	-	-
3	Accipitridae	African Chanting Goshawk	*Melierax metabates*	(Temminck, 1823)	-	-	+	+	-
4	Alcedinidae	Little Paradise-Kingfisher	*Tanysiptera hydrocharis*	(Gray, 1858)	+	+	+	+	+
5	Alcedinidae	African Pygmy-Kingfisher	*Ceyx pictus*	(Boddaert, 1783)	+	+	+	+	+
6	Apodidae	Common Swift	*Apus apus*	(Linnaeus, 1758)	+	+	+	+	-
7	Apodidae	African Black Swift	*Apusbarbatus*	(Sclater, 1865)	-	+	+	+	-
8	Ardeidae	Little Egret	*Egretta garzetta*	(Linnaeus, 1766	+	+	+	+	+
9	Ardeidae	Cattle Egret	*Bubulcus ibis*	(Linnaeus, 1758)	+	+	+	+	+
10	Ardeidae	Rufous-bellied Heron	*Ardeola rufiventris*	(Sundevall, 1851)	+	+	-	-	-
11	Ardeidae	Grey Heron	*Ardea cinerea*	(Linnaeus 1758)	+	-	-	+	-
12	Bucorvidae	Abyssinian Ground-hornbill	*Bucorvus abyssinicus*	(Boddaert, 1783)	+	-	-	-	+
13	Bucorvidae	African Grey Hornbill	*Tockus nasutus*	(Linnaeus, 1766)	+	+	-	-	+
14	Charadrilldae	Hooded Plover	*Thinornis rubicollis*	(Gmelin, 1789)	-	-	+	+	+
15	Columbidae	Mourning Dove	*Zenaida macroura*	(Linnaeus, 1758)	+	+	+	-	+
16	Columbidae	Laughing Dove	*Stigmatopelia senegalensis*	(Linnaeus, 1766)	+	+	-	+	+
17	Columbidae	Red-eyed Dove	*Streptopelia semitorquata*	(Ruppell, 1837)	-	+	+	+	-
18	Columbidae	Vinaceous Dove	*Streptopelia vinacea*	(Gmelin, 1789)	+	+	+	+	-
19	Coraciidae	Abyssinian Roller	*Coracias abyssinicus*	(Linnaeus, 1766)	+	+	+	+	+
20	Cuculidae	Senegal Coucal	*Centropus senegalensis*	(Linnaeus, 1799)	+	+	+	+	+
21	Hirundinidae	Grey- rumped Swallow	*Pseudhirundo griseopyga*	(Sundevall, 1850)	-	+	-	+	+
22	Laridae	Lesser Crested Tern	*Sterna bengalensis*	(Lesson, 1831)	-	-	+	+	-
23	Malaconotidae	Sooty Boubou	*Laniarius leucorhynchus*	(Hartlaub, 1848)	-	+	+	+	-
24	Meropidae	White-throated Bee-eater	*Merops albicollis*	(Vieillot, 1817)	+	+	+	+	+
25	Musophagidae	Western Grey Plantain-eater	*Crinifer piscator*	(Carriker, 1933)	+	-	-	-	+
26	Nectariniidae	Scarlet-chested Sunbird	*Nectarinia senegalensis*	(Linnaeus, 1766)	-	+	-	+	-

27	Numididae	Helmeted Guineafowl	*Numida meleagris*	(Linnaeus, 1766)	+	+	+	+	+
28	Passeridae	Rufous- tailed Weaver	*Histurgops ruficaudus*	(Reichenow, 1887)	-	+	+	-	+
29	Phasianidae	Stone Partridge	*Ptilopachus petrosus*	(Gmelin, 1789)	+	+	+	+	+
30	Phasianidae	Black Francolin	*Francolinus francolinus*	(Linnaeus, 1766)	+	+	+	+	+
31	Picidae	Crimson-crested Woodpecker	*Campephilus melanoleucos*	(Gmelin, 1788)	-	+	-	+	+
32	Platysteiridae	Short- tailed Batis	*Batis mixta*	(Shelley, 1889)	+	+	+	+	+
33	Ploceidae	Black- billed Weaver	*Ploceus melanogaster*	(Shelley, 1887)	+	+	+	+	+
34	Psittacidae	Dusky Parrot	*Pionus fuscus*	(Muller, 1776)	+	-	-	+	-
35	Scopidae	Hamerkop	*Scopus umbretta*	(Gmelin, 1789)	+	-	-	+	-
36	Strigidae	Tawny-browed Owl	*Pulsatrix koeniswaldiana*	(Bertoni & Bertoni, 1901)	+	+	+	+	+
37	Sturnidae	Purple Glossy-starling	*Lamprotornis purpureus*	(Muller, 1776)	+	+	+	+	+
38	Sturnidae	Greater Blue-eared Glossy-starling	*Lamprotornis chalybaeus*	(Ehrenberg, 1828)	+	+	+	+	+
39	Sturnidae	Lesser Blue-eared Glossy-starling	*Lamprotornis chloropterus*	(Swainson, 1838)	+	+	+	+	+
40	Sturnidae	Splendid Glossy-starling	*Lamprotornis splendidus*	(Vieillot, 1822)	+	+	+	+	+
41	Threskiornithidae	Hadada Ibis	*Bostrychia hagedash*	(Latham, 1790)	+	+	+	+	+
42	Trochilidae	Veraguan Mango	*Anthracothorax veraguensis*	(Reichenbach, 1855)	+	+	+	+	+
43	Tyrannidae	Black Phoebe	*Sayornis nigricans*	(Swainson, 1827)	+	+	+	+	+
44	Tyrannidae	Tufted Flycatcher	*Mitrephanes phaeocercus*	(Sclater, 1859)	+	+	+	+	+
					32	34	33	37	30
	Total								166

Source: Field Survey,(2018)

Key: + = Present, − = Absent

Table 2: Relative Abundance of Bird's Species Utilizing the Study Area

S/N	Scientific name	Site 1	Site 2	Site 3	Site 4	Site 5	Total
1	*Polyboroides typus*	0	0	0.88	0.38	0	1.26
2	*Ictinaetus malayensis*	0	0	0.29	0	0	0.29
3	*Melierax metabates*	0	0	6.64	1.77	0	8.41
4	*Tanysiptera hydrocharis*	0.71	6.4	0.74	0.76	1.01	9.62
5	*Ceyx pictus*	5.66	0.94	0.88	1.39	0.58	9.47
6	*Apus apus*	0.71	12.62	7.67	1.52	0	22.52
7	*Apus barbatus*	0	0.56	3.1	0.76	0	4.42
8	*Egretta garzetta*	0.88	0.94	1.18	0.38	0.43	3.81
9	*Bubulcus ibis*	2.12	6.4	3.1	32.45	33.81	77.88
10	*Ardeola rufiventris*	0.35	0.38	0	0	0	0.73
11	*Ardea cinerea*	1.06	0	0	0.25	0	1.31

12	*Bucorvus abyssinicus*	0.71	0	0	0	0.72	1.43
13	*Tockus nasutus*	2.65	2.26	0	0	1.73	6.64
14	*Thinornis rubicollis*	0	0	0.88	0.63	0.58	2.09
15	*Zenaida macroura*	0.71	0.38	0.44	0	0.29	1.82
16	*Stigmatopelia*	2.3	0.75	0	0.76	1.73	5.54
17	*Streptopelia semitorquata*	0	2.26	0.44	0.63	0	3.33
18	*Streptopelia vinacea*	7.79	4.33	2.1	0.51	0	14.73
19	*Coracias abyssinicus*	4.6	0.56	0.88	0.89	2.31	9.24
20	*Centropus senegalensis*	1.06	2.45	7.23	0.76	4.62	16.12
21	*Pseudhirundo griseopyga*	0	0.56	0	0.25	0.29	1.1
22	*Sterna bengalensis*	0	0	8.26	0.51	0	8.77
23	*Laniarius leucorhynchus*	0	2.45	1.77	0.38	0	4.6
24	*Merops albicollis*	4.78	0.94	0.88	3.17	0.87	10.64
25	*Crinifer piscator*	7.43	0	0	0	3.18	10.63
26	*Nectarinia senegalensis*	0	0.38	0	1.52	0	1.9
27	*Numida meleagris*	5.66	1.13	23.0	4.31	17.77	51.87
28	*Histurgops ruficaudus*	0	0.38	0.74	0	0.87	1.99
29	*Ptilopachus petrosus*	2.83	0.75	0.44	3.29	0.58	7.89
30	*Francolinus francolinus*	0.88	0.75	3.1	9.88	1.01	15.62
31	*Melanoleucos campehilus*	0	2.07	0	2.66	3.03	7.76
32	*Batis mixta*	7.61	2.26	4.72	2.91	5.06	22.56
33	*Ploceus melanogaster*	1.06	7.72	3.1	4.18	6.50	22.56
34	*Pionus fuscus*	0.71	0	0	0.38	0	1.09
35	*Scopus umbretta*	3.72	0	0	1.52	0	5.27
36	*Pulsatrix koeniswaldiana*	2.3	3.95	1.62	2.66	0.29	10.82
37	*Lamprotornis purpureus*	4.07	8.47	3.69	4.31	2.02	22.56
38	*Lamprotornis chalybaeus*	5.66	2.26	0.74	1.65	0.87	11.18
39	*Lamprotornis chloropterus*	3.19	4.56	3.54	0.76	1.01	13.06
40	*Lamprotornis splendidus*	1.06	4.89	0.74	5.45	4.62	16.76
41	*Bostrychia hagedash*	5.66	0.94	0.88	1.77	0.29	9.54
42	*Anthracothorax veraguensis*	0.35	0.75	0.44	0.13	0.43	2.11
43	*Sayornis nigricans*	7.78	10.55	3.69	2.66	1.73	26.41
44	*Mitrephanes phaeocercus*	3.89	4.52	2.21	1.77	1.73	14.12
	Total	99.95	101.51	100.01	99.96	99.96	

Source: Field Survey, (2018)

Table 3: Diversity of Bird Species in the Study Area

S/N	Family name	Common name	Scientific name	Number (n)	n(n-1)
1	Accipitridae	African Harrier-hawk	*Polyboroidestypus*	9	72
2	Accipitridae	Black kite	*Ictinaetusmalayensis*	2	2
3	Accipitridae	African Chanting Goshawk	*Melieraxmetabates*	59	3422
4	Alcedinidae	Little Paradise-Kingfisher	*Tanysipterahydrocharis*	56	3080
5	Alcedinidae	African Pygmy-Kingfisher	*Ceyxpictus*	58	3306
6	Apodidae	Common Swift	*Apus apus*	135	18090
7	Apodidae	African Black Swift	*Apus barbatus*	30	870
8	Ardeidae	Little Egret	*Egrettagarzetta*	24	552
9	Ardeidae	Cattle Egret	*Bubulcus ibis*	557	309692
10	Ardeidae	Rufous-bellied Heron	*Ardeolarufiventris*	4	12

11	Ardeidae	Grey Heron	*Ardeacinerea*	8	56
12	Bucorvidae	Abylssinian Ground-hornbill	*Bucorvusabyssinicus*	9	72
13	Bucorvidae	African Grey Hornbill	*Tockusnasutus*	39	1482
14	Charadrilldae	Hooded Plover	*Thinornisrubicollis*	15	210
15	Columbidae	Mourning Dove	*Zenaidamacroura*	11	110
16	Columbidae	Laughing Dove	*Stigmatopelia*	35	1190
17	Columbidae	Red-eyed Dove	*Streptopeliasemitorquata*	20	380
18	Columbidae	Vinaceous Dove	*Streptopeliavinacea*	85	7140
19	Coraciidae	Abyssinian Roller	*Coraciasabyssinicus*	58	3306
20	Cuculidae	Senegal Coucal	*Centropussenegalensis*	106	11130
21	Hirundinidae	Grey- rumped Swallow	*Pseudhirundogriseopyga*	7	42
22	Laridae	Lesser Crested Tern	*Sterna bengalensis*	60	3540
23	Malaconotidae	Sooty Boubou	*Laniariusleucorhynchus*	28	756
24	Meropidae	White-throated Bee-eater	*Meropsalbicollis*	69	4692
25	Musophagidae	Yellow browned toucanet	*Plantain turaco*	64	4032
26	Nectariniidae	Scarlet-chested Sunbird	*Nectariniasenegalensis*	14	182
27	Numididae	Helmeted Guineafowl	*Numidameleagris*	351	122850
28	Passeridae	Rufous- tailed Weaver	*Histurgopsruficaudus*	13	156
29	Phasianidae	Stone Partridge	*Ptilopachuspetrosus*	53	2756
30	Phasianidae	Black Francolin	*Francolinusfrancolinus*	115	13110
31	Picidae	Crimson-crested Woodpecker	*Melanoleucos campehilus*	53	2756
32	Platysteiridae	Short- tailed Batis	*Batismixta*	145	20880
33	Ploceidae	Black- billed Weaver	*Ploceus melanogaster*	146	21170
34	Psittacidae	Dusky Parrot	*Pionusfuscus*	7	42
35	Scopidae	Hamerkop	*Scopus umbretta*	33	1056
36	Strigidae	Tawny-browed Owl	*Pulsatrixkoeniswaldiana*	68	4556
37	Sturnidae	Purple Glossy-starling	*Lamprotornispurpureus*	141	19740
38	Sturnidae	Greater Blue-eared Glossy-starling	*Lamprotornischalybaeus*	68	4556

39	Sturnidae	Lesser Blue-eared Glossy-starling	*Lamprotornischloropterus*	71	4970
40	Sturnidae	Splendid Glossy-starling	*Lamprotornissplendidus*	112	12432
41	Threskiornithidae	Hadada Ibis	*Bostrychiahagedash*	59	3422
42	Trochilidae	Veraguan Mango	*Anthracothoraxveraguensis*	13	156
43	Tyrannidae	Black Phoebe	*Sayornisnigricans*	158	24806
44	Tyrannidae	Tufted Flycatcher	*Mitrephanesphaeocercus*	87	7482
	Total			3255	644314

Simpsons Diversity Index's =0.939

Source: Field Survey, (2018)

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- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.

Format Structure

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, “What words would a source have to include to be truly valuable in a research paper?” Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

Tips for Writing a Good Quality Science Frontier Research Paper

Techniques for writing a good quality Science Frontier Research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of science frontier then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

Segment draft and final research paper: You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

Criterion for Grading a Research Paper (Compilation) by Global Journals

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals.

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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