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CONCEPT : GROUPS

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Groups

1 Definition

The idea of a group has evolved from a concrete measure of symmetry of a mathematical object to an abstract algebraic structure in its own right. The work of Lagrange, Galois and others on groups was motivated by studying the symmetries of the roots of a polynomial equation.

The symmetry of an object is specified by its structure-preserving mappings and the manner in which they compose with one another. It is this notion of a set with a composition which is the basis of the definition.

A *binary operation* on a set G (typically denoted by a symbol like $\circ$) is a function from $G \times G$ to G . We write the value of the function on the pair $(g, h) \in G \times G$ (the result of 'composing' g and h) as $g \circ h$.

A *group* is a set G with a binary operation $\circ$ satisfying the following conditions:

(G1) For all $g, h, k \in G$, we have $g \circ (h \circ k) = (g \circ h) \circ k$ (the *associative law*).

(G2) There is an element $e \in G$ such that $g \circ e = e \circ g = g$ for all $g \in G$.

(G3) For any $g \in G$, there exists $g' \in G$ such that $g \circ g' = g' \circ g = e$.

If it satisfies the additional condition

(G4) For all $g, h \in G$, we have $g \circ h = h \circ g$ (the *commutative law*),

it is said to be an *Abelian group*.

The set of symmetries of a mathematical object (suitably defined) always has the structure of a group, where the operation is composition. For the composition of two symmetries is a symmetry; the identity map is a symmetry; a symmetry is a one-to-one and onto map, and so has an inverse, which is also a symmetry; and composition of maps is always associative.

Symmetry groups can be generalised as follows. A *permutation group* is a set G of permutations (one-to-one and onto maps) of a set Ω which is closed under composition, contains the identity map, and contains the inverse of each of its elements. (A permutation group is a group: the associative law is again automatic.) Thus, each symmetry group is a permutation group. A lot of work has gone into deciding which permutation groups are symmetry groups of objects

Let G be a group. A *subgroup* of G is a non-empty subset which forms a group in its own right, with respect to the operation inherited from G . That is, H must satisfy the conditions

- for all $h_1, h_2 \in H$, we have $h_1 \circ h_2 \in H$ (the *closure law* – if this were not so, we would not have a well-defined operation on H);
- the identity of G is contained in H ;
- the inverse of each element of H is in H .

In fact the second condition follows from the others, and all follow from the single condition

- for all $h_1, h_2 \in H$, we have $h_1 \circ h_2^{-1} \in H$.

We write $H \leq G$ to denote that H is a subgroup of G .

Let H be a subgroup of G . The relation $\sim_r$ on G defined by

$$x \sim_r y \text{ if and only if } xy^{-1} \in H$$

is an equivalence relation on H . Its equivalence classes are called *right cosets* of H in G , and are sets of the form

$$Hx = \{hx : h \in H\}.$$

The element x is called a *right coset representative* for the right coset Hx .

Dually, the relation $\sim_l$ given by

$$x \sim_l y \text{ if and only if } x^{-1}y \in H$$

is an equivalence relation, whose equivalence classes are called *left cosets* of H in G , and have the form

$$xH = \{xh : h \in H\}.$$

The left and right cosets of a given subgroup may give different partitions of the group. But the number of elements in a coset of either type is equal to the number of elements in the subgroup. (For right cosets, the correspondence $h \leftrightarrow hx$ is a bijection between H and Hx . So the number of cosets of either type (the *index* of H in G) is equal to $|G|/|H|$. We deduce *Lagrange's Theorem*:

Theorem 2 *The order of a subgroup H of a finite group G divides the order of G .*

of particular types such as graphs or designs. (Every permutation group is the symmetry group of some suitably constructed object.)

Cayley's Theorem shows that, conversely, every group can be represented as a permutation group. The proof is as follows. (This argument is stated for finite groups but works more generally.) Let $G = \{g_1, g_2, \dots, g_n\}$ be a group. The *Cayley table* of G is the $n \times n$ matrix with (i, j) entry k if $g_i \circ g_j = g_k$. It follows from the group axioms (G2) and (G3) that the Cayley table is a Latin square. Thus, each row is a permutation of $\{1, \dots, n\}$. Now it can be checked that, if π_i is the permutation corresponding to the i th row, then $\pi_i \circ \pi_j = \pi_k$ if and only if $g_i \circ g_j = g_k$. (Here the operation on permutations is composition.) Thus the permutations form a group identical to G .

We say that a group G with operation $\circ$ and a group H with operation $*$ are *isomorphic* if there is a one-to-one correspondence from G to H so that, if g_1 corresponds to h_1 and g_2 to h_2 , then $g_1 \circ g_2$ corresponds to $h_1 * h_2$. Isomorphic groups are 'the same' from an algebraic point of view, even though their elements may be quite different. Thus, Cayley's Theorem really states:

Theorem 1 *Every group is isomorphic to a permutation group.*

The *order* of a group is the number of elements in the group. It may be finite or infinite, but we will be mainly concerned with finite groups.

Two very different examples of groups, one infinite and abelian, the other finite and (almost always) non-abelian:

- the additive group $\mathbb{Z}$ of integers, with the operation of addition;
- the *symmetric group* S_n of degree n ; its elements are all permutations of the set $\{1, \dots, n\}$, and the operation is composition of permutations.

2 Subgroups: Lagrange and Sylow

From now on we suppress explicit mention of the group operation, and write $g_1 g_2$ instead of $g_1 \circ g_2$. This is especially appropriate when we think of the group operation as 'multiplication'. At the same time, we write the group identity as 1, and the inverse of g as g^{-1} .

[Sometimes instead we think of it as 'addition', and write $g_1 + g_2$. This is especially common when the group is abelian. In this case, we write the identity as 0, and the inverse of g as $-g$.]

The converse of Lagrange's Theorem is false; if $|G| = n$ and m divides n , there may be no subgroup of order m in G . One case where such a subgroup exists is given by *Sylow's Theorem*, one of the most important theorems in finite group theory.

Theorem 3 Let G be a group of order $n = p^a \cdot b$, where p is prime and p does not divide b . Then

- (a) G contains a subgroup of order p^a ;
- (b) any two such subgroups P, Q are conjugate (that is, there exists $x \in G$ with $x^{-1}Px = Q$ – this implies that P and Q are isomorphic);
- (c) the number of subgroups of order p^a is congruent to 1 mod p and divides b .

A subgroup whose order is the exact power of the prime p which divides G is called a *Sylow p -subgroup* of G .

3 Normal subgroups and homomorphisms

A subgroup H of G is said to be a *normal subgroup* if its left and right cosets coincide, that is, if $Hx = xH$ for all $x \in G$. This can be expressed in various equivalent ways, for example: H is a normal subgroup if and only if, for all $h \in H$ and $x \in G$, we have $x^{-1}hx \in H$. (The element $x^{-1}hx$ is called a *conjugate* of h .)

If H is a normal subgroup of G , then we can define an operation on the set G/H of (left or right) cosets of H in G by the rule

$$Hx \circ Hy = H(xy).$$

(Of course it is necessary to show that the definition doesn't depend on the choice of coset representatives x and y .) It can be shown that, with this operation, G/H is a group. This group is called the *factor group* or *quotient group* of G by H .

How do normal subgroups arise 'in nature'?

A *homomorphism* from a group G to a group H is a function $\theta : G \rightarrow H$ with the property that

$$\theta(g_1g_2) = \theta(g_1)\theta(g_2)$$

for all $g_1, g_2 \in G$.

Perhaps the most familiar example of a homomorphism is the function from the additive group $\mathbb{Z}$ of integers to the group $\mathbb{Z}/n\mathbb{Z}$ of integers modulo n , for some positive integer n , which maps each integer k to the congruence class $k \bmod n$.

Another example is the *sign map* from the symmetric group S_n to the multiplicative group $\{+1, -1\}$, which maps each permutation to its sign. The sign of a permutation $g \in S_n$ is $(-1)^{n-c(g)}$, where $c(g)$ is the number of cycles of g .)

The *kernel* of a homomorphism θ is the set

$$\text{Ker}(\theta) = \{g \in G : \theta(g) = 1_H\}$$

of elements of G mapped to the identity element of H . The *image* is, as usual, the set

$$\text{Im}(\theta) = \{\theta(g) : g \in G\}$$

of elements of H to which some element of G is mapped. These are described by the *Isomorphism Theorem*:

Theorem 4 *Let θ be a homomorphism from G to H . Then*

- *$\text{Ker}(\theta)$ is a normal subgroup of G ;*
- *$\text{Im}(\theta)$ is a subgroup of H ;*
- *the factor group $G/\text{Ker}(\theta)$ is isomorphic to $\text{Im}(\theta)$.*

Conversely, if H is a normal subgroup of G , then there is a 'canonical' homomorphism having H as its kernel and G/H as its image.

Thus we may say simply 'A normal subgroup is the kernel of a homomorphism.'

4 Simple groups: Jordan–Hölder

A group G always has two trivial normal subgroups, the whole group G and the identity $\{1\}$. It is called *simple* if it has no other normal subgroups, and *composite* otherwise.

An example of a simple group is the *cyclic group* C_p of prime order p , consisting of elements x^i for $i = 0, \dots, p-1$, with composition $x^i x^j = x^{i+j \bmod p}$. By Lagrange's Theorem, this group has no non-trivial subgroups at all!

If G is composite, with a non-trivial normal subgroup H , then we can often reduce questions about G to questions about the smaller groups H and G/H . If

either of these is composite, we can continue the process. Eventually we reach a series

$$\{1\} = G_0 \leq G_1 \leq \cdots \leq G_r = G$$

which cannot be further refined. Thus, for $i = 1, \dots, r$, we have that G_{i-1} is a normal subgroup of G_i , and G_i/G_{i-1} is simple. Such a series is called a *composition series* of G , and the simple groups G_i/G_{i-1} are the *composition factors*. We are only interested in the composition factors up to isomorphism; they form a multiset, since a given simple group may be isomorphic to G_i/G_{i-1} for several values of i .

The *Jordan–Hölder Theorem* states:

Theorem 5 *Any two composition series of a finite group G give rise to the same multiset of composition factors.*

In a sense, this reduces the study of finite groups to two parts:

- determine the finite simple groups;
- determine how a given multiset of finite simple groups can be ‘glued together’ as the composition factors of a finite group.

To indicate just how far we are from a solution of the second problem, here are some computational results obtained recently by Besche, Eick and O’Brien. The number of groups of order 2000 or less is 49,910,529,484. Of these, more than 99% have order $1024 = 2^{10}$. However, for every group of order 2^{10} , the list of composition factors consists of a single group (the cyclic group of order 2) with multiplicity 10. There is a sense in which the most complicated groups are those of prime-power order; such a group has just one composition factor (cyclic of prime order) with the appropriate multiplicity.

However, the first part of the problem has been solved as a result of a major collaborative effort. We proceed to discuss this.

5 The Classification of Finite Simple Groups

The Classification of Finite Simple Groups, or CFSG for short, is probably the largest collaborative mathematical achievement ever. The first proof, covering an estimated 15000 pages in articles often not directly on CFSG at all, was announced

in 1980. It was subsequently found to contain a major gap. The ‘revisionism’ programme was then launched to produce a self-contained proof; this was completed in the early 2000s. Work on a ‘third-generation’ proof is currently underway.

Even the detailed statement of the theorem cannot be given here. Essentially the result is as follows.

Theorem 6 *A finite simple group is of one of the following types:*

- (a) *a cyclic group of prime order;*
- (b) *an alternating group A_n , for $n \geq 5$;*
- (c) *a simple group of Lie type;*
- (d) *one of 26 sporadic simple groups.*

We have already seen the cyclic groups of prime order. Here is a brief description of the remaining groups.

The *alternating group* A_n consists of all even permutations of the set $\{1, \dots, n\}$. We saw earlier that it is the kernel of the sign homomorphism from the symmetric group S_n to C_2 , so it is a normal subgroup of S_n . Galois showed that, for $n \geq 5$, the alternating group A_n is simple (so that the composition factors of S_n are A_n and C_2).

Groups of Lie type are harder to describe. They are closely related to certain matrix groups over finite fields. They fall into a number of families, of which the simplest consists of the projective special linear groups $\text{PSL}(n, q) = \text{SL}(n, q)/Z$, where $\text{SL}(n, q)$ consists of all matrices of determinant 1, and Z is the normal subgroup consisting of scalar matrices. Further families correspond to other ‘classical’ groups (symplectic, orthogonal and unitary) over finite fields, and there are some ‘exceptional’ families constructed from exceptional Lie algebras or automorphisms of other groups. Carter’s book [3] gives details.

The 26 sporadic groups have no uniform definition, but were constructed individually. See the ATLAS [4] for details.

6 Permutation groups

Another essay in this series describes aspects of permutation groups of relevance to design theory. Here we give some corollaries of CFSG for permutation groups.

First, a brief reminder about terminology. A *permutation group* on the set $\{1, \dots, n\}$ is a subgroup of the symmetric group S_n (that is, a group whose elements are permutations and whose operation is composition). The number n is its *degree*. A permutation group G is

- *transitive* if, for any two points of $\{1, \dots, n\}$, there is an element of G which maps the first to the second;
- *primitive* if, for any subset Y of $\{1, \dots, n\}$ satisfying $1 < |Y| < n$, there is an element $g \in G$ with $Y \neq g(Y)$ and $Y \cap g(Y) \neq \emptyset$;
- *t-transitive* (for $1 \leq t \leq n$) if, given any two t -tuples of distinct points, there is an element of G which maps the first to the second.

Among the consequences of CFSG are the following:

- all finite t -transitive groups, for $t \geq 2$, are known (see the lists in [2]);
- for almost all positive integers n , the only primitive groups of degree n are the symmetric and alternating groups;
- primitive groups have small order (with known exceptions);
- there are only finitely many distance-transitive graphs of given valency (greater than 2).

Further details about many of these results appear in [2].

7 Computation

Most familiar programming languages and systems allow the user to handle integers, real numbers, and strings. Modern systems often extend this to vectors, complex numbers, etc. To deal with groups as easily, there are two systems available: GAP [5] and MAGMA [1].

A permutation group often arises in practice as the automorphism group of some structure (graph, design, etc.) The program of choice for testing isomorphism of graphs and other combinatorial objects, and for calculating their automorphism groups, is *nauty* [6]. The GAPshare package GRAPE includes an interface with *nauty*; the automorphism groups of graphs returned by the latter

can be handled directly in GAP. The forthcoming package DESIGN will extend this functionality to designs.

In the remainder of this essay we sketch briefly how permutation groups are handled in a computer.

A group is usually input to the computer by giving a set of permutations which generate it. Now given a set of generators, the *orbit* of a point x (the set of all images of x under elements of G) can be computed by an algorithm similar to that for finding a connected component of a graph: starting with x , add in any point which is the image of an existing point under a generator until the resulting set is closed under all generators. The procedure implicitly finds coset representatives for the stabiliser of x : such a set consists of one element mapping x to each possible image.

Now Schreier's Lemma provides an algorithm which, given generators for a group and coset representatives for a subgroup, finds generators for the subgroup. So we can compute generators for the subgroup G_1 fixing x .

Continuing this process, we find a sequence

$$G = G_0 > G_1 > \cdots > G_d = \{1\}$$

of subgroups of G , where G_i is the stabiliser of points $x_1, \dots, x_i$, for $1 \leq i \leq d$. At this point we can calculate the order of G and can test any permutation for membership in G . Moreover, an element of G is uniquely determined by the images of $x_1, \dots, x_d$, so arbitrary elements of G can be represented in more compact form.

Using this representation, the packages enable the user to compute any group-theoretical properties of interest, including (but far from limited to) Sylow subgroups, composition factors, images of homomorphisms, etc.

It should be mentioned that groups can be handled in other ways too. Instead of permutation generators, we may give matrix generators, or abstract generators and defining relations.

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MATHS PROJECT WORK.

GROUP : II BSc(MPC).

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CONTINUITY

Definition: A function f is continuous at a point $x = a$ if

$$\lim_{x \rightarrow a} f(x) = f(a)$$

In other words, the function f is continuous at a if ALL three of the conditions below are true:

1. $f(a)$ is defined. (i.e., a is in the domain of f .)
2. $\lim_{x \rightarrow a} f(x)$ exists. (i.e., both one-sided limits exist and are equal at a .)
3. $\lim_{x \rightarrow a} f(x) = f(a)$.

If any one of the conditions is false, then we say that f is discontinuous at a , or that it has a discontinuity at a .

A consequence of this definition is that if we know a function f is continuous at a point $x = a$, then we also know that it has a limit at a , equal to $f(a)$.

A function f is said to be continuous from the right at a if

$$\lim_{x \rightarrow a^+} f(x) = f(a).$$

A function f is said to be continuous from the left at a if

$$\lim_{x \rightarrow a^-} f(x) = f(a).$$

A function f is said to be continuous on an interval if it is continuous at each and every point in the interval. Continuity at an endpoint, if one exists, means f is continuous from the right (for the left endpoint) or continuous from the left (for the right endpoint).

ex. $f(x) = 1/x$ is continuous on $(-\infty, 0)$ and on $(0, \infty)$.

ex. $f(x) = \sin x$ is continuous on $(-\infty, \infty)$.

ex. $f(x) = \csc x$ is continuous on $(0, \pi)$, $(\pi, 2\pi)$, $(2\pi, 3\pi)$, $(3\pi, 4\pi)$, ...

Note: Usually, if we say a function is *continuous*, without specifying an interval, we mean that it is continuous everywhere on the real line, i.e. the set of all real numbers $(-\infty, \infty)$. Or that it is continuous at every point of its domain, if its domain does not include all real numbers.

Theorem:

- (i.) Every polynomial function is continuous everywhere on $(-\infty, \infty)$.
- (ii.) Every rational function is continuous everywhere it is defined, i.e., at every point in its domain. Its only discontinuities occur at the zeros of its denominator.

Corollary: If p is a polynomial and a is any number, then

$$\lim_{x \rightarrow a} p(x) = p(a).$$

Similarly, if r is a rational function and a is any number where r is defined, then

$$\lim_{x \rightarrow a} r(x) = r(a).$$

Fact: Every n -th root function, trigonometric, and exponential function is continuous everywhere within its domain.

Continuity of the algebraic combinations of functions

If f and g are both continuous at $x = a$ and c is any constant, then each of the following functions is also continuous at a :

- | | |
|-----------------------------|---------------------|
| 1. $f + g$ | (sum) |
| 2. $f - g$ | (difference) |
| 3. cf | (constant multiple) |
| 4. fg | (product) |
| 5. f/g , if $g(a) \neq 0$ | (quotient) |

ex. $f(x) = x^3 - 2x + \sin x$ and $g(x) = x^2 \cos x$ are both continuous on $(-\infty, \infty)$.

Continuity of composite functions

If g is continuous at $x = a$, and f is continuous at $x = g(a)$, then the composite function $f \circ g$ given by $(f \circ g)(x) = f(g(x))$ is also continuous at a .

That is, the composite of two continuous functions is continuous.

Example: Since both $f(x) = x^2 + 1$ and $g(x) = \cos x$ are continuous on $(-\infty, \infty)$. Therefore, both

$$(f \circ g)(x) = \cos^2 x + 1, \text{ and}$$
$$(g \circ f)(x) = \cos(x^2 + 1)$$

are continuous on $(-\infty, \infty)$.

Discontinuities

Types of discontinuities:

Removable discontinuity

Infinite discontinuity

Jump discontinuity

How to identify the type of a discontinuity?

Suppose f has a discontinuity at $x = a$, but is otherwise continuous on some interval containing a . Then it has

An infinite discontinuity at a if either (or both) of the two one-sided limits is ∞ or $-\infty$. (Therefore, $x = a$ is a vertical asymptote of f .)
ex. $f(x) = 1/x$, at $x = 0$.

A removable discontinuity at a if the two one-sided limits exist and are equal (i.e., the limit exists), but f is either undefined at a , or $\lim_{x \rightarrow a} f(x) \neq f(a)$.
ex. $f(x) = (x^2 - 4) / (x - 2)$, at $x = 2$.

A jump discontinuity at a if the two one-sided limits are not equal (and neither is an infinite limit).

$$\text{ex. } f(x) = \begin{cases} x^2 + 1, & x \leq 1 \\ 1 - x, & x > 1 \end{cases} \quad \text{at } x = 1.$$

The Intermediate Value Theorem

Theorem: Suppose that f is continuous on the closed interval $[a, b]$ and let N be any number between $f(a)$ and $f(b)$, where $f(a) \neq f(b)$. Then there always exists a number c in the open interval (a, b) such that $f(c) = N$.

Application: Root-finding

If f is defined on $[a, b]$ and if either

(i.) $f(a) < 0$ and $f(b) > 0$, or

(ii.) $f(a) > 0$ and $f(b) < 0$,

then the equation $f(x) = 0$ has (at least one) a root on (a, b) .

Proof: Let $N = 0$ be the intermediate value, which is between $f(a)$ and $f(b)$. Apply the Intermediate Value Theorem. The root will be at $x = c$.

Example: $x^3 - x + 1 = 0$ has a root on $(-2, -1)$.

Because $f(-2) = -5$ and $f(-1) = 1$.

Example: Prove that square roots of 2 are real numbers.
(Hint: they are the roots of $x^2 - 2 = 0$.)

Continuity (exercises with detailed solutions)

1. Verify that $f(x) = \sqrt{x}$ is continuous at x_0 for every $x_0 \geq 0$.
2. Verify that $f(x) = \frac{1}{x} - \frac{1}{x_0}$ is continuous at x_0 for every $x_0 \neq 0$.
3. Draw the graph and study the discontinuity points of $f(x) = [\sin x]$.
4. Draw the graph and study the discontinuity points of $f(x) = \sin x - [\sin x]$.
5. Draw the graph and study the discontinuity points of $f(x) = \frac{2x^2 - 5x - 3}{x^2 - 4x + 3}$.
6. Draw the graph and study the discontinuity points of $f(x) = \frac{x + 3}{3x^2 + x^3}$.
7. Find $k \in \mathbb{R}$ such that the function

$$f(x) = \begin{cases} 2x^2 + 4x, & \text{if } x \geq 1 \\ -x + k, & \text{if } x < 1 \end{cases}$$

is continuous on $\mathbb{R}$.

8. Find $a, b \in \mathbb{R}$ such that the function

$$f(x) = \begin{cases} \log(1+x), & \text{if } -1 < x \leq 0 \\ a \sin x + b \cos x & \text{if } 0 < x < \frac{\pi}{2} \\ x & \text{if } x \geq \frac{\pi}{2} \end{cases}$$

is continuous on its domain.

9. Determine the domain and study the continuity of the function $f(x) = \frac{\log(1+x^2)}{\sqrt{3-\sin x}}$.
10. Draw the graph and study the continuity of the function

$$f(x) = \begin{cases} x \left[\frac{1}{x} \right], & \text{if } x \neq 0 \\ 1, & \text{if } x = 0. \end{cases}$$

11. Draw the graph and study the continuity of the function

$$f(x) = \begin{cases} x \sin \frac{1}{x}, & \text{if } x \neq 0 \\ 1, & \text{if } x = 0. \end{cases}$$

Solutions

1. In order to verify that $f(x) = \sqrt{x}$ is continuous at x_0 , with $x_0 \geq 0$, we try to find an upper bound for $f(x)$ dependent on the difference $x - x_0$. We obtain

$$\sqrt{x} - \sqrt{x_0} = \frac{(\sqrt{x} - \sqrt{x_0})(\sqrt{x} + \sqrt{x_0})}{\sqrt{x} + \sqrt{x_0}} = \frac{x - x_0}{\sqrt{x} + \sqrt{x_0}}.$$

Since $\sqrt{x} \geq 0$ for every $x \geq 0$ we have

$$|\sqrt{x} - \sqrt{x_0}| = \frac{|x - x_0|}{\sqrt{x} + \sqrt{x_0}} \leq \frac{|x - x_0|}{\sqrt{x_0}}.$$

We now fix $\varepsilon > 0$, and we want to determine $\delta > 0$, such that if $|x - x_0| < \delta$ then $|f(x) - f(x_0)| < \varepsilon$. From the previous inequality we have that we must find $\delta > 0$, such that if $|x - x_0| < \delta$ then

$$\frac{|x - x_0|}{\sqrt{x_0}} < \varepsilon.$$

The last inequality is equivalent to $|x - x_0| < \sqrt{x_0}\varepsilon$, hence we choose $\delta \leq \sqrt{x_0}\varepsilon$.

2. As in exercise 1 we have to find an upper bound for $f(x) - f(x_0)$, dependent on the difference $x - x_0$ or with a function of $x - x_0$. We have

$$\frac{1}{x} - \frac{1}{x_0} = \frac{x_0 - x}{xx_0}.$$

If $x_0 > 0$ (when $x_0 < 0$ we proceed in the same way), then for every $x \in I =]x_0/2, 3/2x_0[$ we have

$$x \cdot x_0 > \frac{x_0}{2} \cdot x_0 = \frac{x_0^2}{2} \Rightarrow \left| \frac{1}{x} - \frac{1}{x_0} \right| = \frac{|x_0 - x|}{xx_0} < 2 \frac{|x_0 - x|}{x_0^2}.$$

Hence, fixed $\varepsilon > 0$, if we find $\delta > 0$ such that $|x - x_0| < \delta$ implies $2 \frac{|x_0 - x|}{x_0^2} < \varepsilon$, we have finished. This condition is equivalent to $|x - x_0| < \varepsilon \frac{x_0^2}{2}$, and the last inequality is satisfied for every $x \in I$ if we take $\delta \leq \min\{\varepsilon \frac{x_0^2}{2}, \frac{x_0}{2}\}$.

3. Since $\sin x$ is 2π -periodic, f is also 2π -periodic. We then study f only on the interval $[-\pi, \pi]$. Since $[n] = n$ for every $n \in \mathbb{Z}$, then $f(x) = \sin x$ when $x = -\pi, -\pi/2, 0, \pi/2, \pi$. Furthermore $[y] = 0$ for every $y \in [0, 1[$, hence $f(x) = 0$ for every x such that $\sin x \in [0, 1[$, that is for every $x \in [0, \pi] \setminus \{\pi/2\}$.

Similarly, since $[y] = -1$ for every $y \in [-1, 0[$, we have $f(x) = -1$ for every x such that $\sin x \in [-1, 0[$, that is for every $x \in]-\pi, 0]$.

We can then draw the graph of f . At $\pm\pi$ and 0 has a discontinuity f of the first kind, indeed

$$\lim_{x \rightarrow \pm\pi^-} f(x) = 0, \quad \lim_{x \rightarrow \pm\pi^+} f(x) = -1, \quad \lim_{x \rightarrow 0^-} f(x) = -1, \quad \lim_{x \rightarrow 0^+} f(x) = 0,$$

At $x_0 = \pi/2$ f we have

$$\lim_{x \rightarrow \frac{\pi}{2}} f(x) = 0 \quad \text{and} \quad f\left(\frac{\pi}{2}\right) = 1$$

hence we can extend f at $\pi/2$ to a continuous function.

4. f is 2π -periodic and we study it on $[-\pi, \pi]$. To draw its graph we observe that $f(n) = 0, \forall n \in \mathbb{Z}$, hence $f(x) = 0$ for every x such that $\sin x \in \mathbb{Z}$, that is when $x = -\pi, -\pi/2, 0, \pi/2, \pi$. Furthermore, since if $y \in]0, 1[$ we have $y - [y] = y$, then for every $x \in]0, \pi[\setminus \{\pi/2\}$, we have $f(x) = \sin x$. Since if $y \in]-1, 0[$ we have $y - [y] = y + 1$, for every $x \in]\pi, 0[\setminus \{-\pi/2\}$, we have $f(x) = \sin x + 1$. Hence in $x = \pi, 0, \pi/2, \pi$ f has a discontinuity of the first kind, indeed

$$\lim_{x \rightarrow \pm\pi^-} f(x) = 0, \quad \lim_{x \rightarrow \pm\pi^+} f(x) = 1, \quad \lim_{x \rightarrow 0^-} f(x) = 1, \quad \lim_{x \rightarrow 0^+} f(x) = 0.$$

At $x = \frac{\pi}{2}$, f can be extended to a continuous function since

$$\lim_{x \rightarrow \frac{\pi}{2}} f(x) = 1, \quad \text{and} \quad f\left(\frac{\pi}{2}\right) = 0.$$

5. $\text{dom}(f) = \mathbb{R} \setminus \{1, 3\}$. Since the numerator vanishes when $x = 3$ we can simplify the fraction to obtain, for every $x \in \mathbb{R} \setminus \{1, 3\}$

$$f(x) = \frac{(x-3)(2x+1)}{(x-3)(x-1)} = \frac{2x+1}{x-1} = 2 + \frac{3}{x-1}.$$

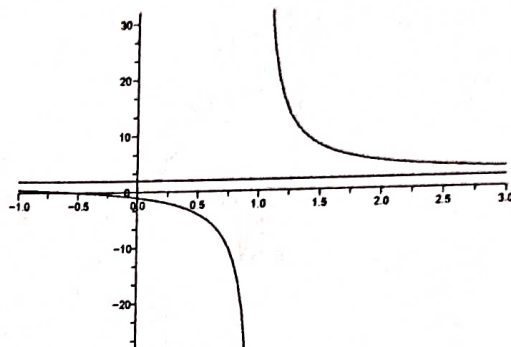
The graph of f can be obtained from the graph of $g(x) = 1/x$ with some translations and rescaling. At $x = 3$ we can extend f to a continuous function, indeed $3 \notin \text{dom}(f)$ but

$$\lim_{x \rightarrow 3} f(x) = \lim_{x \rightarrow 3} \left(2 + \frac{3}{x-1}\right) = \frac{7}{2}.$$

When $x = 1$, we have

$$\lim_{x \rightarrow 1^-} f(x) = -\infty, \quad \lim_{x \rightarrow 1^+} f(x) = +\infty.$$

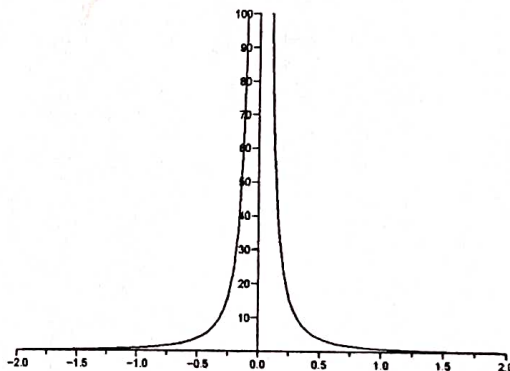
Thus $x = 1$ is a discontinuity point of the second kind.



6. $\text{dom}(f) = \mathbb{R} \setminus \{-3, 0\}$, and for every $x \in \text{dom}(f)$ we have $f(x) = 1/x^2$. Hence we have

$$\lim_{x \rightarrow -3} f(x) = \frac{1}{9}, \quad \lim_{x \rightarrow 0} f(x) = +\infty.$$

we can extend f in $x = -3$ to a continuous function; $x = 0$ is a discontinuity point of the second kind.



7. f is continuous for every $x \neq 1$, since it is a composition of continuous functions. Hence we just study the continuity of f in $x = 1$. f is continuous in $x = 1$ if both limits

$$\lim_{x \rightarrow 1^-} f(x) = \lim_{x \rightarrow 1^-} (-x + k) = k - 1, \quad \lim_{x \rightarrow 1^+} f(x) = \lim_{x \rightarrow 1^+} (2x^2 + 4x) = 6$$

are equal to $f(1) = 6$. We then impose $k - 1 = 6$ that is $k = 7$.

8. $\text{dom}(f) =]-1, +\infty[$. Furthermore on $] -1, 0[$, $]0, \frac{\pi}{2}[$, $] \frac{\pi}{2}, +\infty[$ the function $f(x)$ is continuous because it is a composition of continuous functions. We then study the continuity of f at $x = 0$ and $x = \frac{\pi}{2}$.

We have

$$\lim_{x \rightarrow 0^-} f(x) = \lim_{x \rightarrow 0^-} \log(1+x) = 0, \quad \lim_{x \rightarrow 0^+} f(x) = \lim_{x \rightarrow 0^+} (a \sin x + b \cos x) = b.$$

Hence f is continuous at 0 if and only if $b = 0$. Furthermore

$$\lim_{x \rightarrow \frac{\pi}{2}^-} f(x) = \lim_{x \rightarrow \frac{\pi}{2}^-} (a \sin x + b \cos x) = a, \quad \lim_{x \rightarrow \frac{\pi}{2}^+} f(x) = \lim_{x \rightarrow \frac{\pi}{2}^+} x = \frac{\pi}{2},$$

hence f is continuous in $x = \pi/2$ if and only if $a = \pi/2$.

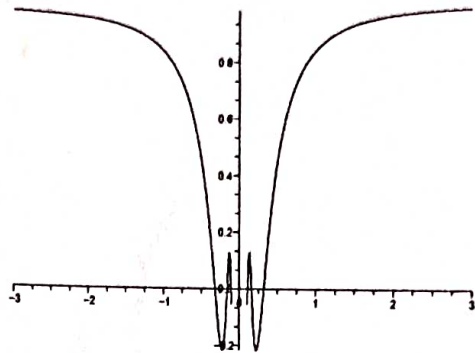
9. $\text{dom}(f) = \mathbb{R}$, indeed for every $x \in \mathbb{R}$ we have $1 + x^2 \geq 1 > 0$ and $3 - \sin x \geq 2 > 0$. For every $x \in \mathbb{R}$ f is continuous since it is a composition of continuous functions.

10. f is not continuous when $x = 1/n$, for every $n \in \mathbb{Z} \setminus \{0\}$. These points are discontinuities of the first kind. When $x \neq 1/n$, f is continuous.

11. f is continuous when $x \neq 0$; at 0 we have

$$\lim_{x \rightarrow 0} f(x) = 0, \quad f(0) = 1.$$

hence we can extend f to a continuous function on the whole $\mathbb{R}$.



T.R.R. GOVT. DEGREE COLLEGE
KANDUKUR, Prakasam Dist.

2019 - 2020



DEPARTMENT OF English

project work

T. R. R. Government

Degree College

English literature Project

Group :- 1 BA - E.E.P - [2019-2020]

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Old English

Old English (500AD - 1100AD) is one of the 3 stages, by which the English language is recognised. This was the language of the Anglo-Saxons and it gradually came to be called Englisc and the land where this was spoken was called Engla-land. However, today it has transformed itself as England. This language exhibited four main dialects: 1. Northumbrian 2. Mercian 3. West Saxon 4. Kentish. Today, though these dialects have merged to form unified English, it is still possible to see variation in the use of language in some areas. 'Beowulf' is a book written during this period which is available to us and can provide samples of Old English.

Features of Old English:

1. Old English was synthetic or fusional, rather than analytic or isolating.

2. There was extensive use of alliteration in Old English poetry.

3. The Noun, Verb, Adjective and Pronoun were highly inflected.

4. Consequently, word order was not rigid as in present-day English.

5. The vocabulary of Old English was overwhelmingly Germanic in character (approximately 85% of the vocabulary used in Old English is no longer in use in Modern English).

wulf

Cynewulf is one of the twelve English poets, known by name

one of four whose work is known to survive today. He probably flourished in the 10th century, with possible dates extending into the late 8th and



9th and 10th centuries. He was born in England, United Kingdom and died away. Known for his religious compositions, Cynewulf is regarded as one of the pre-eminent figures of Anglo-Saxon Christian poetry.

Works: The Poems of Cynewulf - (1836)

Riddles of the Exeter Book

The Andreas (1906)

The Guthlac

Cynewulf's Christ

The Phoenix

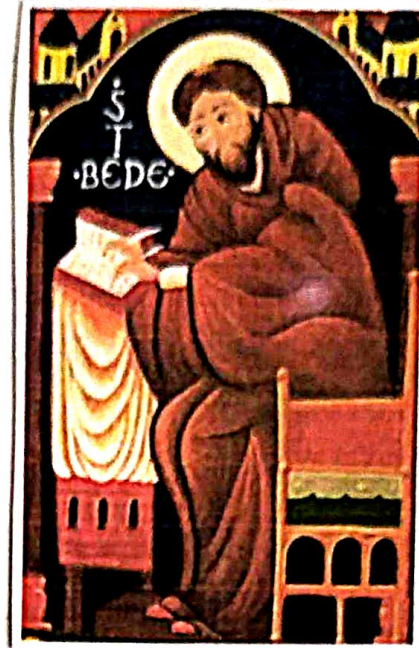
The Harrowing of Hell

The Dream of the Rood

Christ II etc.

le

Bede, also known as Saint Bede,
venerable Bede and Bede the Venerable
an English Benedictine monk
the monastery of St. Peter and
companion monastery of St. Paul
the Kingdom of Northumbria
Angles. He was born in 672 AD,



now, United Kingdom and died on 26th May 735 AD, Jarrow,
United Kingdom

†: 25 May (Western churches) : 27 May (Orthodox church and
the General Roman Calendar from 1899-1969).

Caedmon

Caedmon (AD 657-684) is the first English poet whose name is known. He was born and died at Whitby, Northumbria Kingdom. He was an Anglo-Saxon who cared for the animals at the double monastery of Streonaesholch during the



reign (657-680) of St. Hilda (614-680). He later became a zealous monk and an accomplished and inspirational Christian poet. Caedmon is one of twelve Anglo-Saxon poets identified in medieval sources, one of only three of these for whom biographical information and samples of literary output have survived.

Notes: His only known surviving work is "Caedmon's Hymn", the 20-line alliterative vernacular praise poem in honour of God.

Middle English (c. 1100 - 1450 AD)

Middle English was the result of Norman invasions or the of French rulers under the leadership of William the conqueror, of Normandy. Normans spoke Anglo-Norman which was a product of Germanic languages. Anglo-Norman was highly influenced by Old French and Anglo-Saxon was similarly influenced through Old English. Normans were affluent in comparison with the Anglo-Saxons, and became the rulers. Thus it became both essential and fashionable to learn their language. A combination of Anglo-Saxon and Anglo-Norman gave birth to Middle English.

Features of Middle English

Less standardised, more dialectal variation in the written sources.
Much simpler system of inflections, especially in nouns and adjectives.

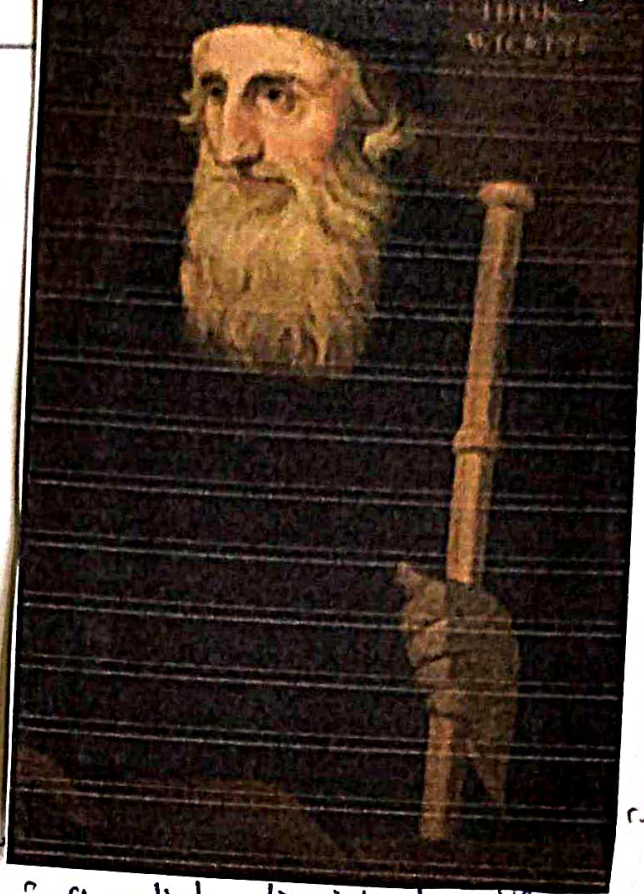
Increased reliance on word-order and prepositions.

Increasingly more mixed vocabulary (French, Latin, Scandinavian).

The development and popularity of the lyric form.

n Wycliffe

John Wycliffe was an English
laic philosopher, theologian,
al translator, reformer, priest and
inary professor at the University
xford. He was born at Hipswell,
d Kingdom 1320's and died
31st December 1384 at Lutterworth,



stershire, England. He became an influential dissident within
Roman Catholic priesthood during the 14th century and is
lered an important predecessor to protestantism.

ts! Wycliffe's Bible

The Last Age of the church (1356)

De Logica (1360)

De Mandatis Divinis (1375)

De civili Domino (1377)

Responsio (1377)

on the Truthfulness of Holy scripture (1378)

on the pastoral office (1378)

De apostasia (1379)

De Eucharistia (1379)

Objections to friars (1380).

William Tyndale!

William Tyndale was born in North Nibley in 1494. He belonged to the age of Middle English. He is also

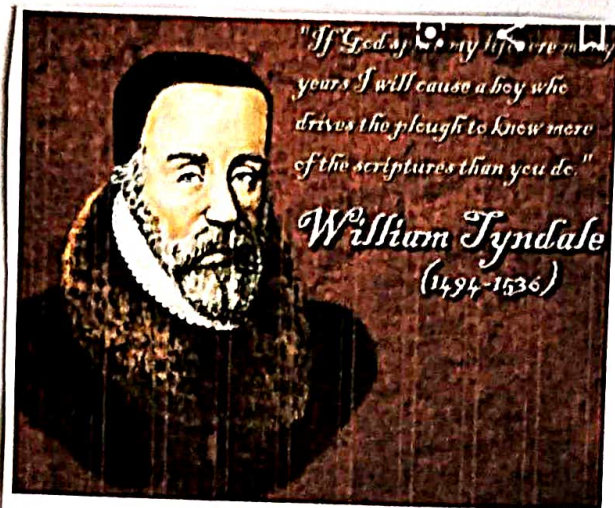
known as William Tindall, William Tynsdale,

or Tindill, William Tyndall. He was

known as Theologian. He passed on

on 6th, 1536, in Vilvoorde.

He was Executed.



Works of William Tyndale

The New Testament - [1526.]

Five books of Moses, called the Pentateuch - [1580]

A prologue unto the Epistle of Paul to the Romans - [1526]

The obedience of a Christian Man - [1528]

An Answer unto Sir Thomas More's Dialogue - [1531]

The supper of the Lord - [1533]

* A Brief Declaration of the sacraments - [1533]

* The Exposition of the first Epistle of St. John - [1531]

Miles Coverdale

Miles Coverdale was born in 1488,
north riding of Yorkshire.

Miles Coverdale, first name also spelt
Miles, was an English ecclesiastical
reformist chiefly known as Bible translator,
teacher and briefly Bishop of Exeter.

Miles Coverdale



Regarding his probable birth country, Daniel Cressely,
John Bale, author of sixteenth century scriptorium, giving
it as Yorkshire.

He was educated in university of Cambridge.
He died on 20 January 1569, London, United Kingdom.

Writings:-

Dans ke folkekirke, order of the church in Denmark,
Pearson George, Bullinger, Heinrich - [1504-1575]

Werdmuller, Otto - [1511-1552]

Coverdale Miles - [1488-1568]

Calvin, Jean - [1509-1564]

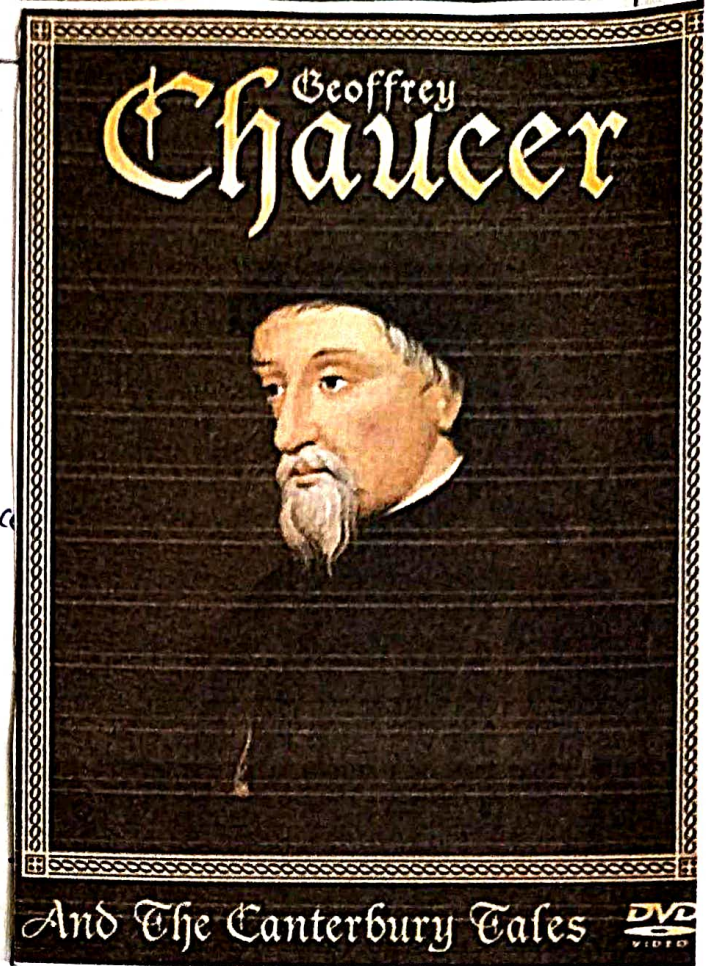
Gyrrasmus, Desiderius.d - [1536]

Geoffrey Chaucer

Geoffrey Chaucer was an English poet author. Widely seen as the greatest English poet of the Middle Ages, he is known for his Canterbury Tales. Chaucer has been styled the "Father of English literature". He was born in 1343, London, England. He also gained fame as a philosopher and astronomer, composing 'Astrolabe' for his 10-year-old son.

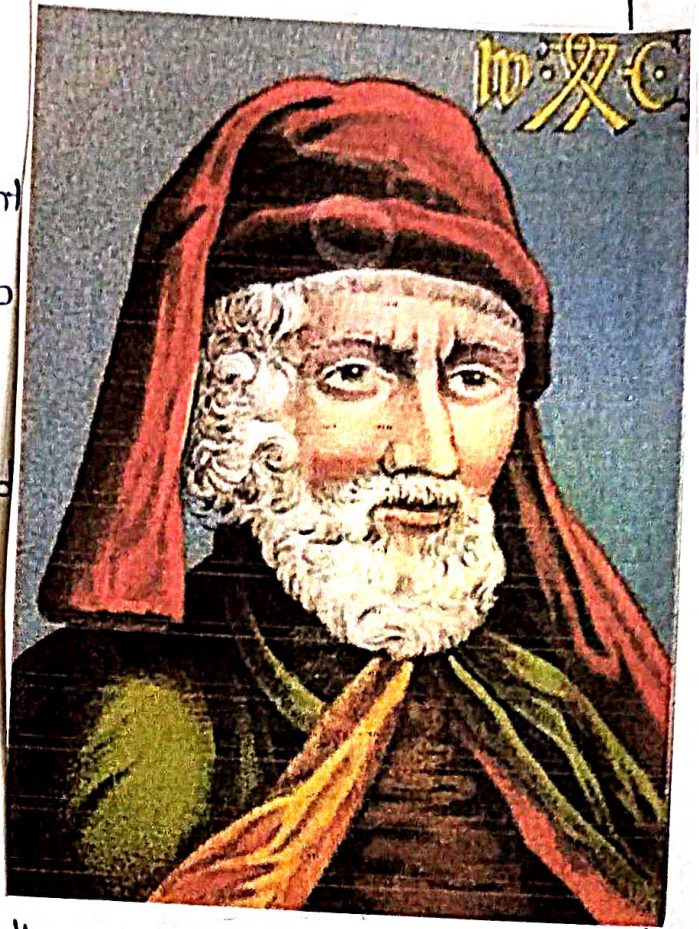
He worked in the civil service as a bureaucrat, courtier, diplomat and a member of parliament. He passed on 25th October 1400, London, United Kingdom.

- Works:
- The Book of the Duchess - [1368]
 - The House of Fame - [1379-1380]
 - Anelida and Arcite - [1378]
 - Parlement of Foules - [1380]
 - Troilus and Criseyde - [1385]
 - The Legend of Good Women - [1380]
 - The Canterbury Tales - [1400]
 - A Treatise on the Astrolabe - [1391]



William Caxton

William Caxton was an English merchant, diplomat and writer. He is thought to be the first person to introduce a printing press into England, in 1476 and a printer was the first English publisher of printed books. He was born c. 1422 and died in c. 1491 resting at St. Margaret's Westminster.



In 2002, Caxton was named among the 100 greatest Britons in a BBC poll.

Notable Works:

1. Recuyell of the Histories of Troye - [1464]
2. Dictes and sayenges of the philosophes - [1477]
3. Brut chronicles - [1528]

25 Wyatt

Thomas Wyatt was a 16th century politician, ambassador and lyric credited with introducing the Sonnet into English literature. He was born in 1542 at Allington Castle near Maidstone Kent, United Kingdom and died



1st October 1542, Clifton, Maybank, United Kingdom. He married Anne Brooke and had Thomas Wyatt the younger.

was educated at St. John's College, Cambridge, University of Cambridge

Works: "Whoso List to Hunt"

"They Flee From Me"

"What No, perdie"

"Luz, My fair Fakon"

"Blome Not My Lute" and

"Tottel's Miscellany" etc.

TRR Govt. Degree College

English literature Project work

Class :- BBA (EEP) (2019-20)

Submitted by :-

Sd. Mansoor
U. Balabrahmaiah
T. Madhusudhan
P. Eswarreddy
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P. Venkata Rao
Manmath
Mahesh
Mahendra

Submitted to

Rajgopal Sir
Ramu Sir

JOHN, DONNE (1572-1631)



Elegy X: The Dream

Image of her whom I love, more than she,
Whose fair impression in my faithful heart
Makes me her medal, and makes her love me.
As Kings do coins, to which their stamps impart
The value: go, and take my heart from hence,
Which now is grown too great and good for me:
Honours oppress weak spirits, and our sense
Strong objects dull: the more, the less we see.

When you are gone, and Reason gone with you,
Then Fantasy is queen and soul, and all:
She can present joys meaner than you do:
Convenient, and more proportional.
So, if I dream I have you, I have you.
For, all our joys are but fantastical.
And so I 'scape the pain, for pain is true:

And sleep which locks up sense, doth lock out all.

After a such trullion I shall wake,
And, but the waking, nothing shall repent:
And shall to love more thankful sonnets make
Than if more honour, tears, and pains were spent.
But dearest heart, and dearer image, stay:
Alas, true joys at best are dream enough:

Though you stay here you pass too fast away:
For even at first life's taper is a snuff.

Fled with her love, may I be rather grown
Mad with much heart, than idiot with none.

John Donne

The Flea

by John Donne

Wake but this flea, and mark in this,
How little that which thou deny'st me is;
It suck'd me first, and now sucks thee,
And in this flea, our two bloods mingled bee,
Thou know'st that this cannot be said,
A sinne, nor shame, nor losse of maidenhead,
Yet this enjoys before it wooe,
And pamper'd swells with one blood made of two,
And this, alas, is more than wee would doe.

Oh stay, three lives in one flea spare,
Where wee almost, yea more than marry'd are,
This flea is you and I, and this
Our marriage bed, and marriage temple is;
Though parents grudge, and you, w^e are met,
And cloyster'd in these living walls of yt.
Though use make you apt to kill mee,
Let not to that, selfe murder add'd bee,
And sacrilegious, three sinnes in killing three.

Cruell and sodaine, hast thou since
Purple'd thy wale, in blood of innocence?
Wherein could this flea guilty bee,
Except in that drop which it suckt from thee?
Yet thou triumph'st, and saist that thou
Find'st not thy selfe, nor mee the weaker now:
'Tis true, then learne how false, feares bee:
Just so much honour, when thou yield'st to mee,
Will wast, as this flea's deaith took life from thee.

Synopsis

The first two editions of John Donne's poems were published posthumously, in 1633 and 1635, after having circulated widely in manuscript copies. Readers continue to find stimulus in his fusion of witty argument with passion, his dramatic rendering of complex states of mind, and his ability to make common words yield up rich poetic meaning. Donne also wrote songs, sonnets and prose.



John Donne was born into a Catholic family in 1572, during a strong anti-Catholic period in England. ... At age 20,

Donne began studying law at Lincoln's Inn and seemed destined for a legal or diplomatic career. During the 1590s, he spent much of his inheritance on women, books and travel. Jun 26, 2019

Birth Date: c. 1572

Education: University of Cambridge, Lincoln's Inn, University of Oxford

Death Date: March 31, 1631

Occupation: Poet

Edmund Spenser (1552-1599)



BORN

1552 or 1553

London, England

DIED

January 13, 1599

London, England

NOTABLE WORKS

- "The Faerie Queene"
- "The Shepheardes Calender"
- "Mutabilitie Cantos"
- "Amoretti"
- "Complaints"
- "A View of the Present State of Ireland"
- "Colin Clouts Come Home Again"

Edmund Spenser (*/ˈspɛnsər/*; 1552/1553 – 13 January 1599) was an English poet best known for *The Faerie Queene*, an epic poem and fantastical allegory celebrating the Tudor dynasty and Elizabeth I. He is recognized as one of the premier craftsmen of nascent Modern English verse, and is often considered one of the greatest poets in the English language. Edmund Spenser was born in East Smithfield, London, around the year 1552, though there is still some ambiguity as to the exact date of his birth. His parenthood is obscure, but he was probably the son of John Spenser, a journeyman clothmaker. As a young boy, he was educated in London at the Merchant Taylors' School and matriculated as a sizar at Pembroke College, Cambridge.^{[7][8]} While at Cambridge he became a friend of Gabriel Harvey and later consulted him, despite their differing views on poetry. In 1578, he became for a short time secretary to John Young, Bishop of Rochester.^[4] In 1579, he published *The Shepheardes Calender* and around the same time married his first wife, Machabyas Childe.^[5] They had two children, Sylvanus (d.1638) and Katherine.^[6]

In July 1580, Spenser went to Ireland in service of the newly appointed Lord Deputy, Arthur Grey, 14th Baron Grey de Wilton. Spenser served under Lord Grey with Walter Raleigh at the Siege of Smerwick massacre.^[7] When Lord Grey was recalled to England, Spenser stayed on in Ireland, having acquired other official posts and lands in the Munster Plantation. Raleigh acquired other nearby Munster estates confiscated in the Second Desmond Rebellion. Some time between 1587 and 1589, Spenser acquired his main estate at Kilcolman, near Doneraile in North Cork.^[8] He later bought a second holding to the south, at Rennie, on a rock overlooking the river Blackwater in North Cork. Its ruins are still visible today. A short distance away grew a tree, locally known as "Spenser's Oak" until it was destroyed in a lightning strike in the 1960s. Local legend has it that he penned some of *The Faerie Queene* under this tree.^[9]

In 1590, Spenser brought out the first three books of his most famous work, *The Faerie Queene*, having travelled to London to publish and promote the work, with the likely assistance of Raleigh. He was successful enough to obtain a life pension of £50 a year from the Queen. He probably hoped to secure a place at court through his poetry, but his next significant publication boldly antagonised the queen's principal secretary, Lord Burghley (William Cecil), through its inclusion of the satirical *Mother Hubbard's Tale*.^[10] He returned to Ireland.

In 1591, Spenser published a translation in verse of Joachim Du Bellay's sonnets, *Les Antiquités de Rome*, which had been published in 1558. Spenser's version, *Ruines of Rome: by Bellay*, may also have been influenced by Latin poems on the same subject, written by Jean or Janis Vitalis and published in 1576.^[11]

By 1594, Spenser's first wife had died, and in that year he married a much younger Elizabeth Boyle, sister of Richard Boyle, 1st Earl of Cork. He addressed to her the sonnet sequence *Amoretti*. The marriage itself was celebrated in *Epithalamion*.^[12] They had a son named Peregrine.^[6]

In 1596, Spenser wrote a prose pamphlet titled *A View of the Present State of Ireland*. This piece, in the form of a dialogue, circulated in manuscript, remaining unpublished until the mid-seventeenth century. It is probable that it was kept out of print during the author's lifetime because of its inflammatory content. The pamphlet argued that Ireland would never be totally "pacified" by the English until its indigenous language and customs had been destroyed, if necessary by violence.^[13]

In 1598, during the Nine Years' War, Spenser was driven from his home by the native Irish forces of Aodh Ó Néill. His castle at Kilcolman was burned, and Ben Jonson, who

may have had private information, asserted that one of his infant children died in the blaze.^[14]

In the year after being driven from his home, 1599, Spenser travelled to London, where he died at the age of forty-six – "for want of bread", according to Ben Jonson – one of Jonson's more doubtful statements, since Spenser had a payment to him authorised by the government and was due his pension.^[15] His coffin was carried to his grave in Poets' Corner in Westminster Abbey by other poets, who threw many pens and pieces of poetry into his grave with many tears. His second wife survived him and remarried twice. His sister Sarah, who had accompanied him to Ireland, married into the Travers family, and her descendants were prominent landowners in Cork for centuries.

Influences[edit]

Though Spenser was well read in classical literature, scholars have noted that his poetry does not rehash tradition, but rather is distinctly his. This individuality may have resulted, to some extent, from a lack of comprehension of the classics. Spenser strove to emulate such ancient Roman poets as Virgil and Ovid, whom he studied during his schooling, but many of his best-known works are notably divergent from those of his predecessors.^[23] The language of his poetry is purposely archaic, reminiscent of earlier works such as *The Canterbury Tales* of Geoffrey Chaucer and *Il Canzoniere* of Francesco Petrarca, whom Spenser greatly admired.

An Anglican^[24] and a devotee of the Protestant Queen Elizabeth, Spenser was particularly offended by the anti-Elizabethan propaganda that some Catholics circulated. Like most Protestants near the time of the Reformation, Spenser saw a Catholic church full of corruption, and he determined that it was not only the wrong religion but the anti-religion. This sentiment is an important backdrop for the battles of *The Faerie Queene*.^[25]

Spenser was called "the Poet's Poet" by Charles Lamb,^[26] and was admired by John Milton, William Blake, William Wordsworth, John Keats, Lord Byron, Alfred Tennyson and others. Among his contemporaries Walter Raleigh wrote a commendatory poem to *The Faerie Queene* in 1590, in which he claims to admire and value Spenser's work more so than any other in the English language. John Milton in his *Areopagitica* mentions "our sage and serious poet Spenser, whom I dare be known to think a better teacher than Scotus or Aquinas".^[27] In the eighteenth century, Alexander Pope compared Spenser to "a mistress, whose faults we see, but love her with them all."^[28]



George Chapman (1559-1634) I. Madhusudan B.A. F.P. Roll No. 02



JACK ^{THE} RIPPER AT LAST?



THE MYSTERIOUS MURDERS OF GEORGE CHAPMAN

HELENA WOJTCZAK



George Chapman

George Chapman (Hitchin, Hertfordshire, c. 1559 – London, 12 May 1634) was an English dramatist, translator and poet. He was a classical scholar whose work shows the influence of Stoicism. Chapman has been speculated to be the Rival Poet of Shakespeare's sonnets by William Shakespeare, and as an anticipator of the metaphysical poets of the 17th century. Chapman is best remembered for his translations of Homer's *Iliad* and *Odyssey*, and the epic *Batrachomyomachia*.

Contents

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Life and work

Chapman was born at Hitchin in Hertfordshire. There is conjecture that he studied at Oxford but did not take a degree, though no reliable evidence affirms this. Very little is known about Chapman's early life, but Mark Eccles uncovered records that reveal much about Chapman's duties and expectations.^[1] In 1585 Chapman was approached in a friendly fashion by John Wolfall, Sr., who offered to supply a bond of surety for a loan to furnish Chapman money "for his better use in Attendance upon the then Right Honorable Sir Rafe Sadler Knight." Chapman's financial ambitions led him into a trap. He apparently never received any money, but he would be indebted for many years by the papers he had signed. Wolfall had the poet arrested for debt in 1600, when in 1608 Wolfall's son, having inherited his father's papers, sued yet again, Chapman's resort was to petition the Court of Chancery for equity.^[2] As Sadler died in 1587, this gives Chapman little time to have trained under him. It seems more likely that he was in Sadler's household from 1577–83, as he dedicates all his Homeric translations to him.

George Chapman



George Chapman. Frontispiece engraving for *The Whole Works of Homer* (1616) attributed to William Hole

Born	c. 1559 Hitchin, Hertfordshire, England
Died	12 May 1634 London
Occupation	Writer
Nationality	English
Period	Elizabethan
Genre	Tragedy, translation
Notable works	<i>Bussy D'Ambois</i> , translations of Homer

Chapman spent the early 1590s abroad, and saw military action in the Low Countries fighting under renowned English general Sir Francis Vere. His earliest published works were the obscure philosophical poems *The Shadow of Night* (1594) and *Ovid's Banquet of Sense* (1595). The latter has been taken as a response to the erotic poems of the age, such as Philip Sidney's *Astrophil and Stella* and Shakespeare's *Venus and Adonis*. Chapman's life was troubled by debt and his inability to find a patron whose fortunes did not decline: Robert Devereux, Second Earl of Essex and the Prince of Wales, Prince Henry both met their ends prematurely. The former was executed for treason by Elizabeth I in 1601, and the latter died of typhoid fever at the age of eighteen in 1612. Chapman's resultant poverty did not diminish his ability or his standing among his fellow Elizabethan poets and dramatists.

Chapman died in London, having lived his latter years in poverty and debt. He was buried at *St Giles in the Fields*. A monument to him designed by Inigo Jones marked his tomb, and stands today inside the church.

Plays

Comedies

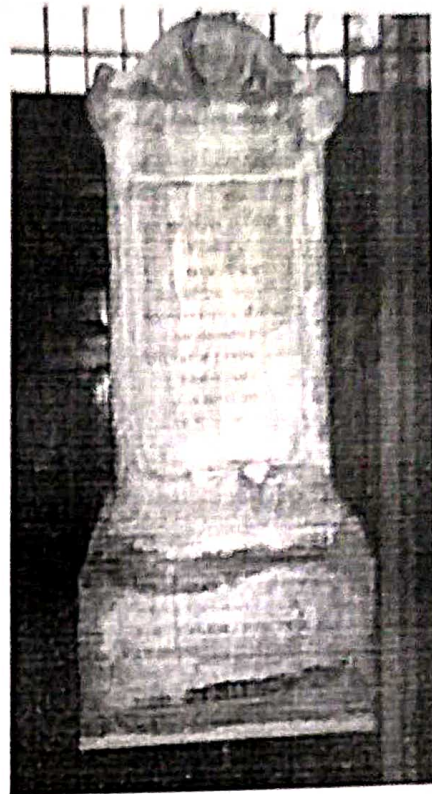
At the end of the 1590s, Chapman had become a successful playwright, working for Philip Henslowe and later for the Children of the Chapel. Among his comedies are *The Blind Beggar of Alexandria* (1596; printed 1598), *An Humorous Day's Mirth* (1597; printed 1599), *All's Well That Ends Well* (printed 1605), *Monsieur D'Olive* (1605; printed 1606), *The Gentleman Usher* (printed 1606), *May Day* (printed 1611), and *The Widow's Tears* (printed 1612). His plays show a willingness to experiment with dramatic form: *An Humorous Day's Mirth* was one of the first plays ever written in the style of "humours comedy" which Ben Jonson later used in *Every Man in His Humour* and *Every Man Out of His Humour*. With *The Widow's Tears*, he was also one of the first writers to meld comedy with more serious themes, creating the tragicomedy later made famous by Beaumont and Fletcher.

Chapman also wrote one noteworthy play in collaboration. *Eastward Ho* (1605), written with Jonson and John Marston, contained satirical references to the Scottish courtiers who formed the retinue of the new king James I; this landed Chapman and Jonson in jail at the suit of Sir James Murray of Colinton, the king's "rascal[ly]" Groom of the Stool.^[3] Various of their letters to the king and Queen survive in a manuscript in the Folger Library known as the *Dobell MS*, and published by E. V. Rieu as *A Seventeenth Century Letterbook*. In the letters, both men renounced the offending line, implying that Marston was responsible for the injurious remark. Jonson's "Conversations With Drummond" refers to the imprisonment, and suggests there was a possibility that both authors would have their "ears and noses slit" as a punishment, but this may have been an elaboration on the story in retrospect.

Chapman's friendship with Jonson broke down, perhaps as a result of Jonson's public feud with Inigo Jones. Some satiric, scathing lines, written sometime after the burning of Jonson's desk and papers, provide evidence of the rift. The poem lampooning Jonson's aggressive behaviour and his believed superiority remained unpublished during Chapman's lifetime; it was found in his papers collected after his death.

Tragedies

Chapman's greatest tragedies took their subject matter from recent French history, the French ambassador taking offence at least one occasion. These include *Bussy D'Ambois* (1607), *The Conspiracy and Tragedy of Charles, Duke of Byron* (1608), *The Revenge of Bussy D'Ambois* (1613) and *The Tragedy of Chabot, Admiral of France* (published 1613). The two Byron plays were banned from the stage—though, when the Court left London, the plays were performed in their original and unexpurgated forms by the children of the Chapel.^[4] The French ambassador probably took offence to a scene which portrays Henry IV's wife and her husband arguing and physically fighting. On publication, the offending material was excised, and Chapman refers to the play as a dedication to Sir Thomas Walsingham as "poore remembered Poems". His only work of classical antiquity, *Caesar and Pompey* (written 1604, published 1631), though "politically astute", can be regarded as his most important achievement in the genre.^{[5][6]}



the Church of St. Giles, London.
The tombstone was designed and paid for by Inigo Jones

Other plays

Chapman wrote one of the most successful masques of the Jacobean era, *The Memorable Masque of the Middle Temple and Lincoln's Inn*, performed on 15 February 1613. According to Kenneth Muir, *The Masque of the Twelve Nights*, performed on Twelfth Night 1619 and first printed by John Payne Collier in 1848 with no author's name attached, is also ascribed to Chapman.^[7]

Chapman's authorship has been argued in connection with a number of other anonymous plays of the early 17th century.^[8] F. G. Fleay proposed that his first play was *The Disguises*. He has been put forward as the author, in whole or in part, of *Sir Giles Goosecap*, *Two Wise Men And All The Rest Fools*, *The Tain Of New Fashions*, and *The Second Maiden's Tragedy*. Of these, only 'Sir Gyles Goosecap' is generally accepted by scholars to have been written by Chapman (*The Plays of George Chapman: The Tragedies, with Sir Giles Goosecap*, edited by Allan Holaday, University of Illinois Press, 1987).

In 1654, bookseller Richard Marriot published the play *Revenge for Honour* as the work of Chapman. Scholars have rejected the attribution; the play may have been written by Henry Wotton. *Alphonsus Emperor of Germany* (also printed 1654) is generally considered another Chapman attribution.^[9]

Most plays *The Fatal Love* and *A Yorkshire Gentlewoman And Her Son* were assigned to Chapman in Stationers' Register entries in 1660. Both of these plays were among the ones destroyed in the famous kitchen burnings by John Warburton's cook. The lost *Christianetta* (registered 1640) may have been a collaboration between Chapman and Richard Brome, or a revision by Brome of a Chapman work.

Editor and translator

her poems by Chapman include: *De Guiana, Carmen Epicum* (1596), on the exploits of Walter Raleigh; a continuation of Christopher Marlowe's unfinished *Hero and Leander* (1598); and *Euthymiae Raptus; or the Tears of Peace* (1609).

we have considered Chapman to be the "rival poet" of Shakespeare's sonnets (in sonnets 78–86), though conjecture places him as one in a large field of possibilities.^{[10][11]}

In 1598 he published his translation of the *Iliad* in instalments. In 1616 the complete *Iliad* and *Odyssey* appeared in *The Whole Works of Homer*, the first complete English translation, which until Pope's was the most popular in the English language and was the way most English speakers encountered these poems. The endeavour was to have been profitable: his patron, Prince Henry, had promised him £300 on its completion plus a pension. However, Henry died in 1633 and his household neglected the commitment, leaving Chapman without either a patron or an income. In an extant letter, Chapman petitions for the money owed him; his petition was ineffective. Chapman's translation of the *Odyssey* is written in iambic pentameter, whereas *Iliad* is written in iambic heptameter. (The Greek original is in dactylic hexameter.) Chapman often extends and elaborates on Homer's original contents to add descriptive detail or moral and philosophical interpretation and emphasis. Chapman's translation of Homer was much admired by John Keats, notably in his famous poem *On First Looking into Chapman's Homer*, and also drew attention from Samuel Taylor Coleridge and T. S. Eliot.

Chapman also translated the *Homeric Hymns*, the *Georgics* of Virgil, *The Works of Hesiod* (1618, dedicated to Francis Bacon), the *Hero and Leander* of Musaeus (1618) and the *Fifth Eclogue* of Juvenal (1624).

Chapman's poetry, though not widely influential on the subsequent development of English poetry, has had a noteworthy effect on the work of T. S. Eliot.^[12]

Image

Percy Bysshe Shelley's poem *The Revolt of Islam*, Shelley quotes a verse of Chapman's image within his dedication "to Mary __ __", presumably his wife Mary Shelley:

There is no danger to a man, that knows
What life and death is: there's not any law
Exceeds his knowledge; neither is it lawful
That he should stoop to any other law.^[13]

Irish playwright Oscar Wilde quoted the same verse in his part fiction, part literary criticism, *Portrait of Mr. W.H.*.^[14]

English poet John Keats wrote "On First Looking into Chapman's Homer" for his friend Charles Cowden Clarke in October 1816. The poem begins "Much have I travell'd in the realms of gold" and is much quoted. For example, P. G. Wodehouse in his review of the first novel of the *Flashman Papers* series that came to his attention: "Now I understand what that 'when a planet swims into his ken' excitement is all about."^[15] Arthur Ransome uses two references to it in his children's books, the *Swallows and Amazons* series.^[16]

Notes

Fish - Preservation

Dissertation submitted to
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In partial fulfillment for the award of the Degree of
Bachelor of Science
IN
ZOOLOGY

By
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Certificate

This is to certify that the dissertation entitled “Fish – Preservation” submitted to Acharya Nagarjuna University, Guntur is a bonafied record of research work carried out by TALAKAYALA KOTESWARI for the award of B.Sc., Degree is a record of the original research work done by her during the period of his study 2020-2021 under my co-supervision in the Department of Zoology, T.R.R. Government Degree College, Kandukur and has not been submitted in part or full for the award of any degree/ diploma / associate ship / fellowship or any other similar title.

Kandukur

K.R. Shanmugam
(Dr.K.R.SHANMUGAM)
Research Supervisor

Date : 07/08/2021.

Project is evaluated by
Nagarajw.p.
7/8/21

DECLARATION

I TALAKAYALA KOTESWARI B.Sc. (Final), Department of Zoology, TRR Government Degree College, Kandukur, A.P, do hereby declare that the dissertation entitled "Fish – Preservation" is carried out by me under the guidance of Dr.K.R.Shanmugam Research Supervisor, Assistant Professor Department of Zoology, T.R.R Govt, Degree college Kandukur Prakasham(Dt), A.P. This work is original and has not been submitted for any other degree or diploma.

Place: Kandukur.

Date: 07/08/2021.


T. KOTESWARI

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AQUACULTURE

Preservation of Fish:-

Definition:-

It is the Production of fish through farming, or rearing in confined Waters. Following prescribed Producers to yield higher returns in terms of numbers and weight through definite management practices and control over the stock.

Aquaculture:

- Refer to all forms of culture of Aquatic animal fish shrimp, Shell fish in fresh, marine and brackish water.

Aquatic counter part of Agriculture:-

- Fish is an excellent source of protein, containing all 10 Essential amid acids.

Objectives of Aquaculture:-

- The boost national economy by bay of increasing per capital production for per capital income.

History of Aquaculture:-

- 4000 years ago first identifiable fish ponds were built by Sumerians in their temples followed by Assyrians and other races.
- Ancient Sumerians kept wild-caught fish in ponds, before preparing them for meals.

Fish culture in India:-

- In India fish culture practice come from writing of Kautiloya's "Arthshastra" 321-300 BC
- King someswara of Chanakya dynasty the fish in ponds in work titled "Mansoltara"
- After a long period of silence collection and transport of carp spawn from rivers and stocking ponds was developed traditionally in Bengal Bihar and Orissa by the end of 19th Century.

Dr. Sunder lal hora helps in development of fish culture in Bengal.

ICAR:-

- Indian council of Agricultural research.
- Started fisheries research scheme by state government and universities on different aspects of fish culture.
- Central inland fisheries research station:-Barrack pore, West Bengal in 1947

Importance of Aquaculture:-

- There is a growing demand for Aquaculture.
- Sea food being the most common food all around the world.
- Aquaculture helps us learn more about fish and sea food and in future help us to re-build some of our wild fish stocks.
- Product of the same size colour and taste can be supplied to meet the needs of buyers.
- Helps to develop genetically engineered species like transgenic fish.

Benefits of Aquaculture:-

- To create employment opportunities.
- To properly utilize the available natural resources.
- To up lift socio-economic status of people.
- To earn foreign exchange.
- To culture fishes of ornamental value black molly, Red sword tail, blue gourami, kissing Guarani for Aquarist.

Fresh Water Species:-

- Catla-Catla,
- Labeo rohita,
- Labeo bata,
- Cirrhinus mrigala.

Marine Water Species:-

- Chanos,
- Mullet,
- Tilapia,
- Common carp,
- Tuna.

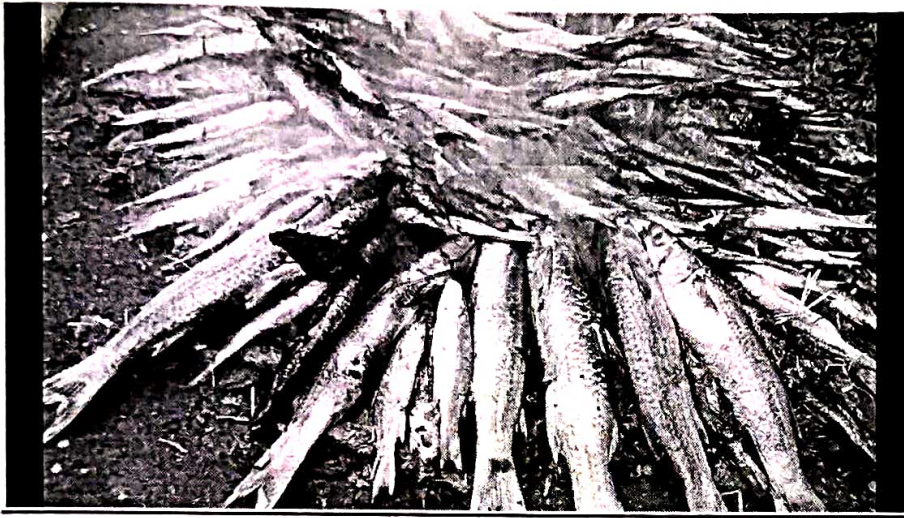
Brackish Water Species:-

- Cyprinidonti forms,
- Cat fish,

Traditional methods of fish preservation:

Smoking of fish:-

- It is done for 2 purposes.
- For preservation.
- For texture and flavour.
- Smoking is much common in less developed countries where refrigeration and transportation facilities are not very good.
- Smoking is very popular in developed countries for taste.



Steps in smoking include:-

Preparation of fish:-

- Scales, head fins, tail, viscera are removed and fish are washed with clean and cold water.

Curing of fish:-

- It can be done in two ways.

(A) Wet/Brine curing:-

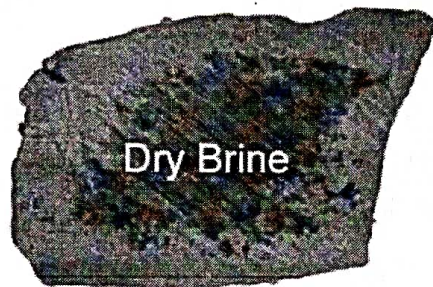
- Ingredients used for brine curing are 3 cups table salt 1 ½ cups brown sugar and 1 gallon of cold water.
- Other spices may also add as per choice.
- All these are mixed properly in a non-metallic container.
- Fish is completely immersed in brine one gallon of brine is sufficient for curing four pounds of fish.
- It is then refrigerated or kept in bags to keep the fish cool.
- Brining is done for 2 to 6 hours.

Brine Penetration a



Dry Curing:-

- In this salt is rubbed directly on the fish.
- Four these three parts of brown sugar is mixed with one part of non-iodized salt and fish fillets are placed in a deep non-metallic pan.
- The piece is covered with dry cure mix and kept in refrigerator for 18-24 hours.
- During dry curing moisture will come out of the fish making.
- After curing, fish are taken out rinsed tightly, put dried and placed on paper towel and air dried for 1 hour



Sun drying:-

- Salted fish may be dried in sun or by artificial heat and air generated by fans.



Drying and de-hydration:-

- Oldest method of preserving food items like fish and i9s considered as least costly method

Advantages:-

- Due to high concentration and diminished water content, spoilage due to microbes and enzymes are avoided.
- It is simple and cheap method
- Further, dried fish may be stored at most ambient temperature

De- Merits:

- No control over drying conditions
- Dependency on natural weather
- Greater chance of contamination with darts, dust and infestation with sects, their eggs and larvae.

De- Hydration:

- The drying carried out in controlled conditions
- De-hydrated fish have high quality and longer shelf life than sun dried fish.
- Various driers like cabinet drier kiln drier tunnel drier etc, are used.



Fermentation:-

- Fermented fish have been considered as a south East Asian product for long.
- Fermented fish products are prepared by salting and fermenting the fish to convert the flesh to simple components.
- Fish fermentation lasts for 3-9 months and the flesh thickly or becomes like a paste
- Fermentation of fish means any fishy products having decreptive changes due to enzymatic or microbe activity.
- Some common fermented fish products are nuoc e-man of Vietnam, nam-pla of Thailand, sushi of Japan and patis of Philippines.
- Fermentation and drying without salting.
- fermentation with salting but without drying

Diagram:-



Pickling:-

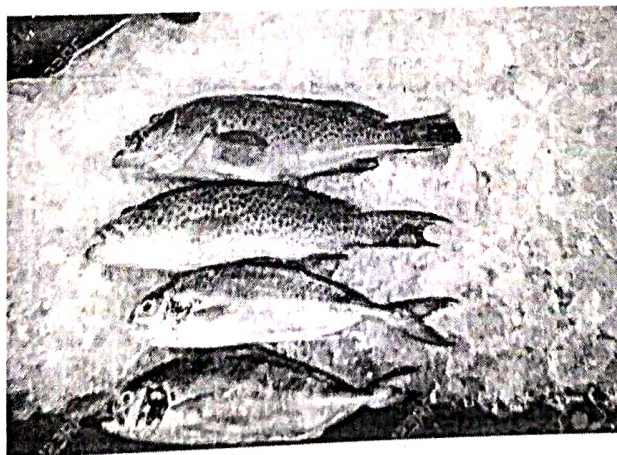
- Pickling is an easy method of preserving fish.
- Pickled fish must be stored in the refrigerator at no higher than 46°F and for best flavour must be used within four to six weeks.
- Only a few species of fish are preserved commercially by pickling but almost any type of fish may be pickled at home.
- Refrigerate the fish during all stages of the pickling process.



Advanced methods of fish preservation:-

1) Chilling:-

- This is obtained by covering the fish with layers of ice
- However, ice alone is not effective for long preservation.
- Because melting water brings about sort of leaching of valuable flesh contents
- Which are responsible for the flavour?
- But ice is effective for short term
- Preservation such as is needed to transport landed fish to nearby markets or to canning factories etc.
-



Freezing:-



- This is more effective than chilling.
- Freezing is achieved either by using a mixture of ice and salt refrigeration.
- The Sub Zero temperature so obtained keeps the fish frozen throughout.
- To prevent rancidity; the frozen fish is subject to glazing with water or it is wrapped in a cover of moisture Proof wax paper.
- Glazing is dipping the frozen fish in Water So that finally layer of a hard ice surrounds the fish.
-
- This layer affords Protection again. Exposure of fish fat to atmospheric oxygen, thus preventing rancidity.

Cannings:-

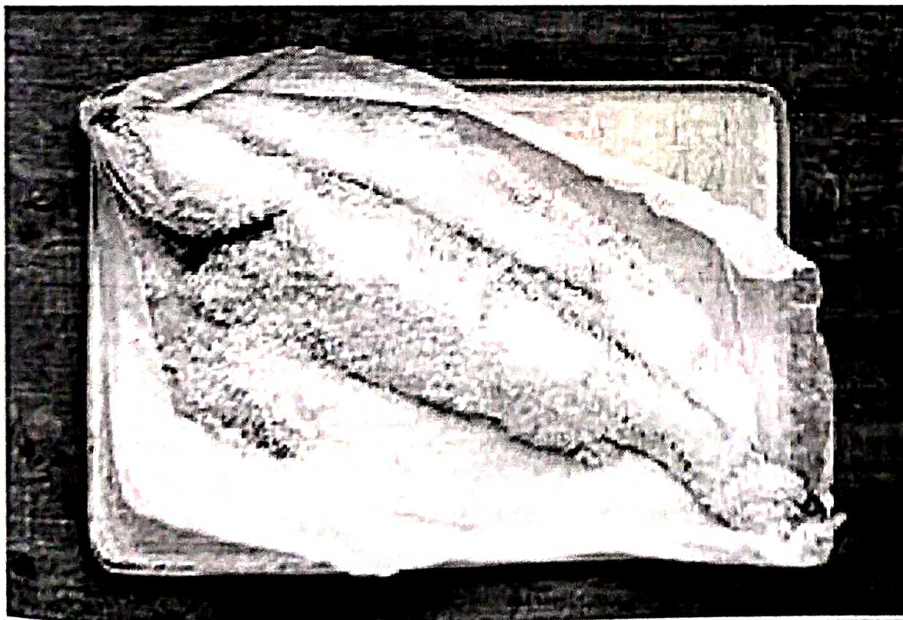
- This is a very effective method though costly
- Product is very good and retains much of flavour.
- Fish is cleaned and then cut to proper bone less pieces in filleting plants.
- The pieces are then brined Pickled to improve taste.
- Preliminary cooking is then carried out.
- Cooked pieces are then put in cans
- Final cooking combines Sterilization with The Steam and high temperature at 110°C
- The cans are finally sealed in canneries



Methods of fish preservation:

Salting:-

- Salt is the Preservative agent used to length then the shelf life fish fishery products.
- This is used in almost all methods of preservation except in icing, refrigerate and freezing
- There many different kinds of salt some being better than other for fish curing.



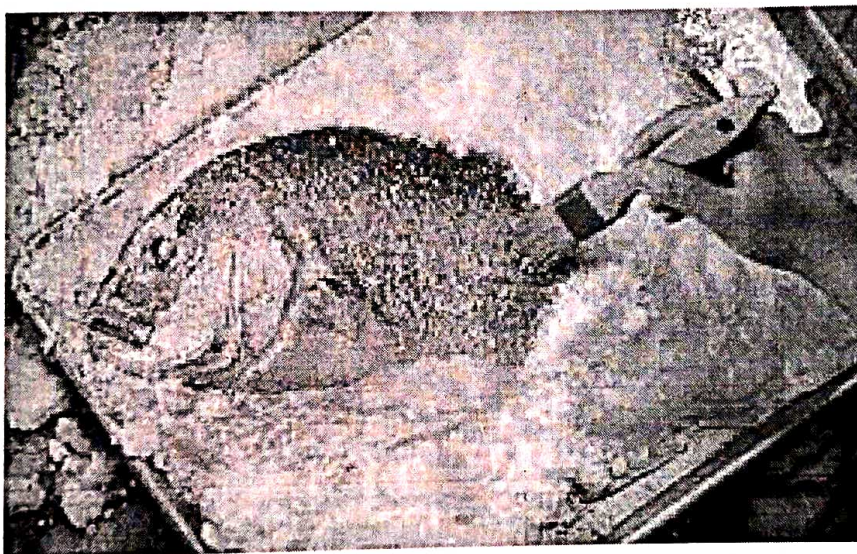
- A distinction the must be made between the two chief technique of salting and wet Salting dry Salting.

Wet Salting:-

- This is the cheaper since it requires lesser amount of Salt.
- The principle is to keep the fish for a long time in brine
- The equipment needed consists of water tight container, which can be a tin, drum barrel etc.,
- To make the brine, one takes four parts of clean water and one part of salt
- If the salt is coarse, it has to be ground or pounded first.
- It is then dissolved in to the water by Stirring with piece of wood.
- To be good, the brine must float a Fish

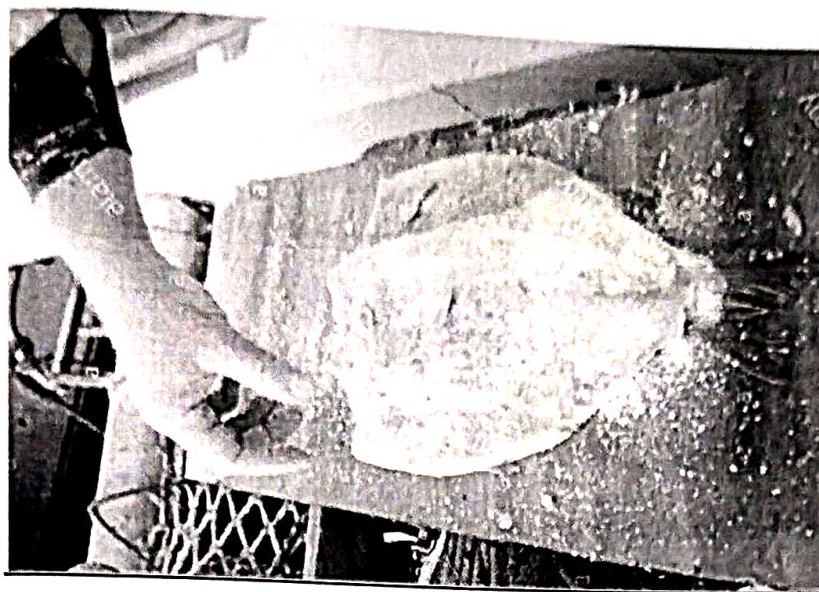
- The next step depends on kind of fish one wants to salt.
-
- It is best first to cut off the head and gut, and clean the fish, through small fish can also be Salted whole.
- Large fish must be cut open, and it is Preferable, able to take out the bacteria.

- Fish with heavy armour of scales must be Scaled
- In places where the flesh is thick, slashes must be made so that the Salted brine cab penetrates the flesh.



Dry salting:-

- In this method the fish is salted but the Juices, Slime and brine are allowed to flow away.
- Dry Salting can be done. In an old canoe, or on mats leaves boxes etc.,
- In case the brine formed by the fish Juice and the Salt must be allowed to run away.
- For two parts of fish one needs one part of salt.
- Layers of fish must be separated by layers of Salt.
- It is a valuable method when one has no containers.



Conclusion:-

Aquaculture is none of the oldest culture for the cultivation of fishes and prawns. In this method there are many methods for fish or prawns preservations. Through fish methods fish can be preserved and later it will be used

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