CHAPTER — I

A SHORT HISTORICO-CRITICAL SURVEY OF THE PROBLEM OF INDUCTION

ARISTOTLE'S VIEW

In the history of philosophy Aristotle was the first philosopher who made a systematic treatment of Induction, although he never used the term `Induction'. What he called `Epāgoge' is roughly equivalent to what is called `Induction' in literature.

Aristotle's use of the term `Epāgoge' is not exactly the same as that of the term Induction, as it is used in contemporary literature. Therefore we should be careful in explaining what Aristotle actually meant by Induction. Aristotle mentions two forms of Induction:

1. Intuitive Induction
2. Induction by simple enumeration

Let us try to understand the second one first.

According to Aristotle "For all conviction is produced either by syllogism or by induction."[1] From this it follows that Aristotle tries to understand induction in contrast to syllogism.

"A syllogism is an argument of some such form as `All animals are mortal, all men are animals; therefore all men are mortal'. Here the predicate is proved to hold of the subject of the conclusion by means of a middle term, and the conclusion is said to be mediated by, or grounded in, its premisses".[2] The example he gives of induction is the following.

> Man, the horse, and the mule are long-lived;
> Man, the horse, and the mule are all the bileless animals.
> Therefore all the bileless animals must be long-lived.

The modern logicians will agree with Aristotle that the above is an example of induction, provided that the words "must be" in the conclusion is not taken seriously. According to them the premisses of the above argument do not guarantee the truth of the conclusion. The premisses supply only partial evidence for the conclusion. But Aristotle would insist the words "must be" should be taken seriously and the premisses of the above argument guarantee the truth of the conclusion, because for him, man, the horse, and the mule, constitute all the bileless animals, i.e. there are no bileless animals which are other than man, the horse, the mule.

In the opinion of the modern logicians the above example of induction as it is explained by Aristotle is actually a kind of deduction. A deduction or a deductive argument is one in

which it is impossible for the premisses to be true and the conclusion false. If we take Aristotle's account of induction as it is exemplified above, it turns out to be a deductive argument rather than an inductive one. But certainly the above example is not an example of what Aristotle calls `syllogism'.

The essential property of a syllogism is that, in it the conclusion is established with the help of the middle term. This characteristic is absent in the above argument. For this we should not blame Aristotle for confusing deduction with induction, because Aristotle never claimed that induction is opposed to deduction; rather he claimed that induction is opposed to syllogism as we have already pointed out. So induction, for Aristotle is an inference from particular to general without the mediation of the middle term. But in the above example of induction we are establishing the conclusion which is a general truth by an enumeration of all the sub-classes or instances. Therefore it is sometimes called enumerative induction or Perfect induction.

Induction and syllogism according to Aristotle are the two fundamentally different modes of advance in thought. Since an induction is a passage from particular to universal, it should be regarded as a real inference and an advance in thought. But it may be objected that we do not really make any advance in thought by means of the above type of inference.

This is a mistaken criticism for in saying that all bileless animals are long-lived, "we are further on the way towards apprehending a rational connection".[3] Therefore enumerative induction is a different kind of argument than a syllogism and moreover by means of this inference we make genuine advance in thought.

But the question is: How do we know the truth of the universal proposition that man, the horse and the mule constitute all the bileless animals ? This is a general truth which establishes a connection between some species and a genus. In order to know this we have to know that all the individuals are under those species are connected with that genus. In other words, to say that man, the horse, and the mule are bileless animals is to say that all the members of the species of man, horse and mule are bileless animals. Unless we can establish the latter connection we are not in a position to say that the former connection holds good. So the question is: How do we know that all men, all horses and all mules are bileless animals ? In order to answer this question we have to step into the notion of intuitive induction.

The insight of Aristotle in answering this question may be compared with that of the Naiyayikas of Indian Philosophy. According to Nyaya whenever we have the sense experience of a particular individual, we also have experience of the universal.

When for example we see a particular cow, we also see the essence of a cow in it, and through the apprehension of this essence we can apprehend all those individuals which have this essence and thus we are some how aware of all the cows of the world. This kind of apprehension is done by what is called perception through universal Sāmānya-Lakshana-Pratyaksha.

In order to explain how this universal content is established in the soul, Aristotle says "from perception arises memory and from repeated memory of the same thing experience. And from experience i.e. when the whole universal (the one distinct from the many and identical in all its instances) has come to rest in the soul - there comes the beginning of art and science-of art if the concern is with becoming, of science if with what is".[4]

Thus according to Aristotle, these states of knowledge arise ultimately from perception. He writes, "The soul is so constituted as to be capable of this. To be more precise; When an infima species has made a stand, the earliest universal is present in the soul; for while what we perceive is an individual, the faculty of perception is of the universal - of man, not of (e.g.) the man Callias".[5]

Thus for Aristotle both science and arts come to men through experience or what may be called sense perception which

is a "congenial discriminative capacity" possessed by men qua animals. When we have mainly notions gained by experience, we have one universal judgement about a class of objects.

Thus it is clear that the knowledge of the universal is obtained through an intellectual intuition which is sometimes called intuitive induction. But this intellectual induction is to be distinguished from Cartesian intuition because this state of knowledge is not "innate in a determinate form". It is a kind of induction which exhibits "the universals as implicit in the clearly known particular".[6]

Since according to Aristotle scientific knowledge is discursive and is acquired through demonstration, and since demonstration cannot be the basis of demonstration, it must be preceded by this intuitive induction which gives us the knowledge of the primary premisses which serve as the premisses of the demonstration. Therefore intuitive induction lies at the very root of demonstration which produces scientific knowledge. Aristotle writes "It will be intuition that apprehends the primary premisses - a result which also follows from the fact that demonstration cannot be the originative source of demonstration, nor consequently, of scientific knowledge".[7]

Thus the knowledge of the universal acquired through intuitive induction constitutes the primary premisses of the

demonstration or what may be called syllogism. And this intuitive induction is gained through sense perception. This is why we have said that the basic insight of Aristotle resembles very much that of the Naiyayikas when they say that an universal is known through sense perception and it is through this universal that we come to perceive all the members that fall within the class determined by that universal. When for example, we know Callias qua man we know also all the members of the class Man and when we know the red colour qua extended we can make the universal judgement that all colours are extended.

We may conclude by pointing out some differences between Aristotle's view on induction and the modern view. Modern logicians claim that the premisses of an inductive argument supply only partial evidence for the conclusion. So the conclusion of the inductive argument is never claimed to be certain. If the premisses are true the conclusion may be said to be true in all probability. In other words premisses yield a probable conclusion; there is no necessay connection between the premisses and the conclusion in an inductive argument. The modern logicians contrast induction with deduction in this respect. The essense of a deductive argument is, according to them, that the relation between the premisses and the conclusion is necessary. If the premisses are true in a deductive argument the conclusion must also be true. But Aristotle did not contrast induction with deduction. That is why for Aristotle induction

does not yield probable conclusion. The premisses of enumerative induction supply conclusive evidence to the conclusion and thus there is a necessary connection between the premisses and the conclusion of an inductive argument. Therefore in the case of inductive argument Aristotle said that the conclusion must be true also.

The charge against Aristotle that his theory of induction is not different from what we call deduction may be valid. But it may be pointed out at the same time that there is a difference between induction and syllogism. Aristotle contrasts his enumerative induction with syllogism in which the conclusion is arrived at by means of a middle term. From this it follows that deduction is of two varieties - i.e. `syllogistic deduction and non-syllogistic deduction'. Aristotle's enumerative induction falls under non-syllogistic deduction.

Although enumerative induction and intuitive induction seem to be two entirely different processes of knowing the universal, yet both of them are classified under inference which he calls induction, because both of them arrive at general proposition from particular proposition. According to Aristotle induction is a process by means of which we can go to the general from the particulars. But in syllogism it never happens. That syllogism will be fallicious in which the premisses are particular and the conclusion is universal. According to rules

of syllogism universal proposition cannot be inferred from premisses all of which are particular propositions. The conclusion of the syllogism can never be wider in scope than the premisses, but the conclusion of an inductive argument is wider in scope from the premisses. If the conclusion of the syllogism is universal then at least one of the premisses must be universal. In order to ascertain the truth of that universal premiss we can take the help of the another syllogism where that premiss is the conclusion. But this conclusion again must be derived from atleast another universal proposition. All such universal premisses cannot be ascertained by syllogism because that will lead to an infinite process. Therefore atleast some universal premiss must be capable of being ascertained by some non-syllogistic method. This non-syllogistic method is what is called induction by Aristotle. Aristotle's notion of intuitive induction seems to be absent in modern logic. This intuitive induction also is a sure source of knowledge. So the modern view that the notion of induction is connected with the notion of probablity is absent in Aristotle. Therefore Aristotle's view of induction may not be accepted by the modern logicians. But from it, it does not follow that Aristotle did not have the notion of induction, which is different from his notion of syllogism.

BACON'S INDUCTIVE METHOD

Bacon is strongly dominated by the idea that his philosophy of induction will help mankind to discover new facts in sciences. Bacon introduces his method to overcome the shortcomings of Aristotle's method, and he also wants to give novelty in sciences. Although Bacon accepts the main outline of Aristotle's Inductive-Deductive theory of scientific procedure, yet he refutes minute details of the procedure. Out of a few observations Aristotelians leap at once to sweeping general conclusions in their method. But a single contradictory instance can upset it, because they ignore the importance of negative instances.

According to Bacon `Induction' is primarily observation and collection of facts. He says, "Man being the servant and interpreter of nature, can do, and understand so much and so much only as he has observed, in fact or in thought,or the course of nature; beyond this he neither knows anything nor can do anything".[1]

Bacon regards Induction in the light of analogy. According to him the things analogous must be discovered and correctly observed. Bacon uses similarity as an instrument in the aid of his method.

There are some important stages in Bacon's Inductive method. According to him we should collect a large number of instances in which the phenomena under investigation occur. Consequently he stresses that, "A natural and experimental history must be prepared sufficient and good".[2]

Bacon says that after establishing facts in a particular science we should discover the correlation among them. There may be some accidental correlation among them. For the removal of accidental correlation he propounds the `Method of exclusion'. By this method we can distinguish essential correlation from accidental correlation.

In Bacon's inductive method `Negative Instances' are very important. By Negative Instances he understands that if a certain phenomenon is being investigated, instances must be found in which this phenomenon is absent. Bacon says that we can find out the essential correlation by the table of presence, table of absence, and the table of degrees.

According to Bacon when instances have been collected by observation then we should arrange them in the following systematic `Tables of Investigation'. All the examples used in explaining the tables have been taken from Bacon's book `Novum Organum'.

1. Table of Presence: In this table the phenomenon is present in all the instances; for example, if "the subject to be inquired into is heat, we should include in our table the sun, lightining flame, burning glasses, the blood of mammals, hot iron etc."[3]

2. Table of Absence: In this table the phenomenon is absent in all the instances. The negative table of heat would contain such instances as "moon's rays, blood of fish, dead animals".[4]

3 Table of Degree: In this table the phenomenon is in various degrees; for example "heat is unequal in various kind of flames".[5]

Later development of `Induction' is based on these tables. Some philosophers are heavily influenced by these tables. For instance, Mill's methods of Agreement, Difference and Concomitance Variations are based on these tables.

According to Bacon after collecting the instances by these three tables we should proceed to induction by exclusion or rejection of non-essentials. For example, as it is noticed that mammal's blood is hot and fish's blood is cold, then the hasty conclusion that blood of all animals is hot is rejected.

Bacon says that in some cases it is difficult to find out essential correlation merely by inspecting Table of Presence,

Table of Absence, and Table of Degrees. According to him there are different types of `Prerogative Instances', which have important roles for the search of essential correlation. In `Novum Organum' he says, that we should "Understand characteristics of the phenomenon selected from great miscellaneous mass of fact which occur in nature....."[6]

There are 27 `Prerogative Instances' but the following are the principal ones among them:

1 Solitary Instances: Solitary Instances are those which exibit the nature under investigation in subjects which have nothing in common with other subjects except that nature.

2 Glaring or striking Instances: Glaring or striking instances are those "which exhibit the nature in question naked and standing by itself, and also in its exaltation of highest degree of power".[7]

3 Clandestine Instances: These instances are just the opposite of the striking ones. They exhibit the nature under investigation in its lower degree of power.

4. Instance of the Fingerpost: Bacon not only gives us a method of discovery in science, but he also tries to give a method by which, choice can be made between rival discoveries, this method

is "Instance of Fingerpost". This is a famous and important `Prerogative Instance'. According to Bacon when a particular experiment will enable us to decide between two rival theories, then that experiment may be called `Crucial Instance' or `Instance of Fingerpost'. It's result decides which of the two theories will be better.

Bacon himself suggests a crucial instance of this type, to decide between two hypothesis about the ebb and flow of the tides. "The first hypothesis was that the tides are in advance and retreat of water, and analogy to water rocked to and fro in a basin. The second hypothesis was that the tides are in a periodic lifting and falling of water. The basin hypothesis would be falsified if it could be shown, that the temporally coincident high tides on the shores of Spain and Florida were not accompanied by ebb tides elsewhere". Bacon suggested that a "study of tides on the coasts of Peru and China would settle the issue".[8]

But we see that a number of natural instances are interrelated at the same time. If a natural instance A is correlated to a natural instance B, an observer must try to find out the important relations that simultaneously hold with A and condition A. Similar observation must be made with relation to B as well. The basin hypothesis seems oversimplified, because it takes the two related fact namely `the coasts of China' and `the

coasts of Peru' without taking into consideration the important conditioning factors of the events, such as the nature of oceanic winds, gravitational pull, oceanic currents and other such ecological factors. In short, natural phenomena are not devoid of conditioning instance and therefore should not be treated in isolation. Here, however an attempt is not being made to solve the problem of choosing between rival theories. All that is being done is to point out the short-comings of Bacon's method shown in the Fingerpost example.

According to Bacon the task of `Inductive Method' is to discover what he calls `Forms' of given nature. Forms are necessary and sufficient conditions of nature. The world is ultimately made of by the existance of a small number of simple forms.

Aristotle says that there are four causes, but according to Bacon there is only one cause that is `Formal Cause'. The so-called other causes "are desultory and superficial and of scarcely any avail towards real and active knowledge".[9] The work and aim of human knowledge is to discover the Form of a thing. Bacon says that Forms are universal and essence of things. Universe is a collection of substances.

Bacon's Forms are neither platonic nor Aristotelian Formal cause. He quotes with approval of Plato's dictum that

"Forms are the true objects of knowledge", but he felt that Plato committed a mistake by separating the Forms or ideas from the things themselves. Plato regarded `Forms' in an abstract and intellectual way. Bacon says that `Forms' are not additional realities - copies or shadow or abstract entities. They are the very essence of things.

According to Bacon "The Form of any given nature is such that given the form the nature infallibly follows. It is always present when the nature is present and universally implies it, is constantly inherent in it. Again the `Form' is such that if it be taken away the nature infallibly vanishes. Therefore, it is always absent when nature is absent and implies its absence and inheres in nothing else"[10]

Bacon points out that the Forms show the relations among `simple nature'. According to him there is a limitation of the number of simple forms and the various combination of these simple nature constitute objects of our exprience. Bacon says that if we are able to know them or discover them it will be easy to build up the entire knowledge of the universe.

In Book II of `Novum Organum' Bacon writes "When I speak of Form, I mean nothing more than those laws and determination of absolute which actually govern and constitute any simple nature as heat, light, weight in every kind of matter and subject that

is susceptible to them. Thus the form of heat and form of light is the same thing as the law of heat and law of light."[11]

The whole concept of `Form' is debatable. What does he mean by relations among `simple nature' ? Is there any such thing as the simple nature of a thing ? If we hypostatise that nature is in continuous flux or the simple nature is relative then what type of relations can be called Forms ? By talking of Forms of heat, whiteness, is he not falling back into a metaphysical trap, which he is trying to avoid ? If a scientific method leads to the search of such Forms then that method definitely seems metaphysically value-loaded. It seems that here Bacon accepts Form as a separate category. But if Form is universal then all the criticism of Resemblance philosophers against universalists will arise in this context.In consequence, this reminds one of the famous controversies between the Resemblance philosophers and universalists.[12]

If Form is taken as `Laws' the confusion is magnified, not resolved. Laws are universal but they are not universal in an absolute sense. Every law is an approximate law. It cannot be either ultimately true or false. The history of science bears evidence to repeated revisions in the basic laws of natural science. The example of the law of heat is an exemplary case. Heat has been explained at different times and simultaneously by different laws. Two different laws sometimes can be employed for

the same subject-matter e.g. "a liquid cannot be both a system of discrete particles and also a continuous medium; though laws dealing with the properties of liquids adopt, one assumpion in some cases and the opposing assumption in others".[13] If Baconian Forms are to be treated as scientific laws then there arises a problem of finding laws which satisfy the definition of Forms.

Science in its progress has not followed the Baconian Method. The process of scientific discovery involves an important act of judgement. Bacon gives the importance to the operation of collection of facts. But he fails to see how deeply the act of judgement must be involved in the effective collection of facts.

There may be many causes of a thing but Bacon says that any phenomenon cannot have more than one cause. This seems unacceptable. Bacon does not make clear how the first vintage (or the first attempt at the interpretation of nature drawn from the tables) is to affect the subsequent steps of inquiry.

J. G. Crowther says in his book `Francis Bacon' that "Perhaps Bacon has not taught anybody a method, but he found out and described essential features of the inductive method".[14] It is said that Bacon invented the `Inductive Method' but it is a controversial point. According to some philosophers Inductive

Method had already beeen introduced before Bacon.

It should be appreciated that Bacon was the first man who gave a particualar experiment, namely `Instance of Fingerpost', by which a choice can be made betwees rival discoveries or rival theories. His technical contributions to the analysis and development of Inductive Method are also important.

Though Bacon's method is full of shortcomings and ambiguities yet it is highly interesting and informative. This is a striking example in the history of science where one's failures and fumbling moves have also been educative.

J. S. MILL ON INDUCTION

As an empiricist Mill believes that all knowledge is derived from experience, and ideas are combined through the laws of association. In other words, our knowledge is derived from specific aposteriori facts. He says that basically all reasoning is inductive.

According to Mill Induction is a process of inference which consists in "The operation of discovering and proving general proposition"[1]. He believes that discovering general propositions is not a matter of inventing anything, but a process of finding out the true statements about the world or about valid inference. By this process we conclude that what is true of certain individuals of a class is true of the whole class or that what is true at certain time will be true in similar circumstances at all times.

Mill argues that "Induction depends on a belief in the uniformity of nature" or we can say that uniformity of nature is a fundamental principle of Induction. He says that the very statement of what induction is, requires an assumption concerning the order of the universe and the course of nature. The assumption is that "there are such things in nature as parallel cases; that what happens once will,under a sufficient degree of similarity of circumstances, happen again".[2]

This assumption may be expressed in various ways: that nature is uniform, that universe is governed by general laws, that the same cause under similar circumstances will be accompanied by the same effect, or that the future will resemble the past. All these expressions mean that nature behaves in the same way under the same circumstances. The phenomena of nature are governed by fixed laws. For example, fire burnt in the past, it will burn in future also under the same conditions.

According to Mill uniformity of nature does not mean that there is no variety of nature. "The course of nature,in truth, is not only uniform, it is also infinitely various"[3]. "..... the contemplation of that uniformity in course of nature which is assumed in every inference from experience, one of the first observations that present themselves is, that the uniformity in question is not properly uniformity, but uniformities"[4]. Mill distinguishes two types of uniformities, i.e. uniformities of coexistence and uniformities of succession. When we affirm that `all crows are black' we assert a uniformity of coexistence. We assert that the property of blackness invariably coexists with the properties which constitute the class of crows. On the other hand the uniformities of succession are causal uniformities and depend upon the law of universal causation.

Mill says that there are various phenomena of nature

which are governed by the same law. Although they are different from one another, they are similar in nature and governed by the same law. For example, ebb and tide, motion of planets, gravitation of the earth are different from one another yet they are governed by the same law of attraction.

Mill maintains that uniformity of nature is based on experience. It is an induction by simple enumeration derived from a large number of similar instances. However he also accepts that uniformity of nature is the ground of induction.

But here the problem arises that the uniformity of nature is the ground of induction and induction by simple enumeration is the ground of the uniformity of nature. Induction by simple enumeration relies upon the uniformity of nature, then how can it prove the uniformity of nature ? Thus Mill's argument for the uniformity of nature involves paradox.

Mill maintains that there is no other uniformity in the events of nature than that which arises from the law of causation. According to him the notion of cause is the root of the whole theory of induction. He says "The law of causation, the recognition of which is the main pillar of inductive science, is but the familiar truth that invariability of succession is found by observation to obtain between every fact in nature and some other fact that has preceded it"[5]. He adds that invariable

relation between events involving constant conjunction. He tries to dispense with the notion of necessary connection by defining cause as an unconditional and invariable antecedent.

Mill says that universal causation `that every event has a cause' is itself established by induction. There is a paradox in Mill's argument. On the one hand he says that our inductive process assumes the law of causation. On the other hand he says that the law of causation is itself established by induction.

According to Mill the law of universal causation is justified by enumerative induction. He argues that enumerative induction is valid , if the confirmed generalizations have very wide scope and are confirmed by a wide variety of experiences.

J.P.Day refutes Mill's defence of the law of causation. According to him "Mill's proof of the causal law is circular in the following sense. On the one hand he says that the law of causation `Every event has a cause' is proved true by enumerative induction from the fact of the existence of numerous true causal laws such as `Malaria is caused by anopheles'. On the other hand he says that such a causal law is properly proved true by the method of difference - that is by a deductive argument in which it is shown to follow necessarily from the true premisses, one of which is the law of causation."[7]

Mill introduces five types of experimental methods for the search of causes. The experimental methods sometimes have been called by Mill `The Methods of Eliminative Induction.' Elimination is a process of negation. With the help of this process accidental circumstances may be excluded. But positively their function is the discovery and proof of a causal connection.

According to Mill all inference from experience are made by means of these experimental methods. He says "If no discoveries were ever made by the methods ....., non were ever made by observation and experiment for assuredly if any were, it was by process of reducible to one or other of those methods."[8]

Mill's inductive method of experimental enquiry is similar to the Bacon's famous table of presence, absence and degrees. Mill, like `Hume', wishes to attribute the description of causation to the association of ideas. For example if we have always perceived A followed by B, this association is formed in our minds, and on the basis of it we conclude that A is the cause of B. Hume had been unable to show that such subjective habit forms a logical justification for the validity of causal analysis.

Mill tries to solve this problem by advancing five experimental methods by which valid association of ideas can be distinguished. He explains these methods much more clearly than

Bacon. Mill's well known methods are:

(a) Method of agreement

(b) Method of difference

(c) Joint method of agreement and difference

(d) Method of concomitant variations

(e) Method of residues

These methods are the foundation of experimental enquiry. These methods are based on the law of causation.

1. The Method of Agreement : This method is called the method of agreement because it requires a number of positive instances of a phenomenon which agree only in one other circumstance. They contain only one common antecedent. Hence the common antecedent and the common consequent are supposed to be causally connected.

The method of agreement is a method of observation. It can find out the cause of a given phenomenon and also the effect of a given cause. According to Mill the canon of the method of agreement is as follows. "If two or more instances of the phenomenon under investigation have only one circumstances in common, the circumstances in which alone all the instances agree, is the cause (or effect) of the given phenomenon."[9]

We can understand it by a concrete example. A bar of

iron, when heated, expands; a bar of silver, when heated, expands; a bar of copper, when heated expands. Here `expansion' has one common antecedent, heat; therefore heat is the cause of expansion.

The object of this method is to eliminate all antecedents except one in order to show that so long as one particular antecedent continues, a particular consequent follows. According to Mill we must employ the canon to discover the cause of some phenomenon.

G.H. von Wright refutes Mill's method of agreement. "In the logic of Mill the word `cause' means sufficient conditions. For this reason the method of Agreement as described by Mill can be used as a method of elimination solely for the purpose of looking for the effect of a given cause and not for the cause of a given effect." This however was overlooked by Mill. On the other hand, "the fact although not clearly grasped by Mill, that the method when applied to sufficient condition was not one of the elimination but of enumeration drove him to the reservation which he expressed by saying that this method can prove a characteristic to be invariable, but not unconditional."[10]

The method of agreement being a method of observation often fails to eliminate all the irrelavent circumstances except one, because of the complexity of the phenomena. For example, it

is very difficult to analyse all the conditions of a political revolution; an economic depression or a complicated disease and to eliminate all the variable and irrelevant antecedents; so it is difficult to find out the cause and effect of such complex phenomena by employing the method of Agreement.

The method of agreement does not provide a watertight proof because there is such a thing as plurality of causes. The same phenomenon is not always produced by the same cause. For example a house may be destroyed by fire or an earthquake or by heavy rains etc. Consequently the method cannot find the cause. It was such a reflection which compelled Mill to recognise an imperfection in the canon of agreement and which led him to supplement it with the canon of difference.

2 Method of Difference:- The method of agreement was recognised by Mill as an imperfect method, because we cannot be certain that the phenomenon investigated has only one cause. Mill believes that the shortcoming of the method of agreement can be overcome by this method. Mill regards the method of difference to be the most important instrument for discovering causal relations.

Method of difference requires two instances which resemble each other in every other respect, but differ in the presence or absence of the phenomenon investigated. Its canon

states "If an instance in which the phenomenon under investigation occurs and an instance in which it does not occur, have every circumstance in common save one, that one occuring only in the former; the circumstances in which alone the two instances differ is the effect, or the cause or an indispensible part of the cause of phenomenon."[11]

For example if A, B, C is followed by a,b,c and B,C is followed by b,c then according to the method of difference we can conclude that A is the cause of a, or an indispensable condition of it. We can take an example of a bottle of coconut oil and apply heat to it, we find that the oil melts immediately after the application of heat. Therefore heat is the cause of melting of oil.

Mill argues that for any particular argument by method of Difference "it is certain that in this instance at least A was either the cause or a indispensable portion of its cause, even though the cause which produces it in other instances may be altogether different"[12]

Mill's position in the above quotation is that a single application of the method of difference can establish that each occurence of a circumstance must be followed by a corresponding phenomenon.

There is no problem of the plurality of causes in the method of difference according to Mill. His claim is that "plurality of causes..... not only does not diminish the reliance due to the method of difference, but does not even render a greater number of observation, or experiments necessary: two instances, the one positive and the other negative are still sufficient for the most complete and rigorous induction."[13]

According to Mill the particular effect may be produced by different causes at different times, but there is no doubt that in this instance a particular antecedent is the cause of a particular consequent. For example a man takes opium and dies. Though death may be due to different causes at different times, but there is no doubt that in this instance it is caused by opium.

Mill believes that any argument which has the form of the method of difference proves causual connection. Mill will have to show that the connection is both invariable and unconditional. This claim is based on two premisses and Mill is unable to establish that either premiss is true.

The first premiss is that the positive and negative instances which fit the scheme of difference differ in just one relevant circumstance. According to him in many cases sequence have been observed to be invariable despite the fact that only a

small number of circumstances have been taken into account. But this does not prove that no further circumstances could be relevant to the occurrence and non-occurrence of the phenomena.

The second premiss is the principle of universal causation. Mill believes that the truth of the universal law of causation is established on empirical grounds. He acknowledges that there is a paradox because if the law of causation is to be proved by experience, then it must be itself the conclusion of an inductive argument. But every inductive argument presupposes the truth of the `Uniformity of nature'. Mill himself recognises that his proof involves a vicious circle and the law of causation cannot be proved by an inductive argument using the method of Difference.

According to Mill this circularity can be avoided by means of a thesis about inductive arguments by simple enumeration. It is surprising that he depends here on a kind of reasoning which he thinks unreliable in the inquiries of science. He says that "the precariousness of the method of simple enumeration is in a inverse ratio to the largeness of the generalization. The process is delusive and insufficient exactly in proportion as the subject-matter of the observation is special and limited in extent. As the sphere widens this unscientific method becomes less and less liable to mislead; and the most universal class of truths, the law of causation for

instance.....(is) duly and satisfactorily proved by that method alone".[14]

Mill claims that an inductive argument by simple enumeration from empirical premisses proves law of causation to be a necessary truth. Mill requires that the law of causation be a necessary truth in order to justify his claim that argument which fits the method of difference proves causal connection.

3. Joint method of Agreement and Difference: This method is a combination of the method of Difference and method of Agreement. The positive instances illustrate the principle of the method of agreement and the negative instances illustrate the principle of the method of difference. When the phenomenon is dependent upon a complex set of conditions, it is difficult to separate the factors involved and vary them at one time. Therefore Mill proposes a combination of the two preceding methods. It's formulation is:

"If two or more instances in which the one phenomenon occurs have only one circumstance in common, while two or more instances in which it does not occur have nothing in common save the absence of that circumstance, the circumstance in which alone the two sets of instances differ is the effect, or the cause, or an indispensable part of the cause, of the phenomenon".[15]

According to this canon we require two sets of instances. In one set the phenomenon occurs and the instances taken together must have a single common circumstance, and in the second set the phenomenon does not occur, and the instances must be so chosen that they have nothing in common. For example,

If A,B,C followed by p,q,r
A,D,E followed by p,u,v
A,F,G followed by p,s,t
and
If B,C,M followed by q,r,m
D,F,N followed by s,t,n
F.G,O followed by u,v,o

according to the joint method we can conclude that A is the cause of p, or is causally related. In the above example when A is present p is present and when A is absent p is absent. So according to the definition of joint method we can establish causal relation between A and p.

Suppose we wish to discover the cause of divorce. According to this method we will have to examine a number of divorced couples, and in the second place we will have to examine a number of cases where divorce has not occured for example among children, bachelors etc. But we cannot use these negative instances to determine the cause of divorce. The negative

instances must be of a type in which the phenomenon is capable of being present when the proper conditions are supplied.

Joint Method neglects the qualitative aspect of causality. Mill considers this aspect in the method of concomitant variation.

4. The Method of Concomitant Variation: The object of this method is to vary the antecedent and consequent in cases in which it is not possible to eliminate them completely. Suppose we want to find out the cause of rise and fall of the tides of rivers and seas, we cannot use the method of difference because sun and moon are the causes of tides and we cannot eliminate the action of sun and moon in any instance. We cannot use the method of agreement either because we cannot remove from the instances of tidal behaviour such common circumstances as the presence of the fixed stars. In such cases we can introduce variation in the degrees and find out a corresponding variation in some circumstances, without completely eliminating either the effect or the supposed cause. For this type of cases Mill formulates the method of concomitant variation; It's canon is:

"Whatever phenomenon varies in any manner whenever another phenomenon varies in some particular manner, is either a cause or an efect of that phenomenon or is connected with it through some fact of causation".[16] Concomitant variation may be

illustrated thus:

A^{+} BC is followed by a^{+} b

A^{o} BC is followed by a^{o} b

A^{-} BC is followed by a^{-} b

If so, then according to this method A is causally related to a. The following is a concrete illustration of this method. If in a cup of tea we go on increasing the quantity of sugar, without introducing any other change, then we will find that sweetness of the tea goes on increasing. Hence according to this method sweetness of tea is due to sugar.

According to Mill concomitant variation means variation of two phenomena together side by side. To vary together or concomitantly may mean either that both phenomena increase together or that both diminish together, or that one increases as the other diminishes or vice versa. In fact, any sort of variation in one phenomenon accompanying a variation in another, comes within the scope of this method. Such a concomitance in variation may sometime be produced by experiment, and it may also be discovered by observation. Consequently this method has a very wide scope.

This method is applicable to the investigation of permanent causes. There are certain phenomena such as gravitation, heat, friction, pressure, etc. which can never be

eliminated altogether and therefore can be investigated only in their varying degrees. For example, we cannot completely eliminate atmospheric pressure, but we can put ourselves in position, where we can observe its variation. As we ascend on mountain higher and higher we find the atmospheric pressure less and less. These agencies which cannot be completely eliminated are called by Mill `permanent cause'. They can be investigated by the method of concomitant variation.

Moreover, there are dangers of reaching at wrong conclusion by this method. For exmple, in the above mentioned case one can reach the false conclusion that our climbing a mountain is the cause of the atmospheric pressure, but actually this is not the case. Sometimes co-effects are mistakenly treated as cause and effect on the basis of this method. For example, if the death of rats increases, the plague increases and if the death of rats decreases the plague decreases. Hence according to this method death of rats becomes the cause of plague, but they are really co-effects of the biting of a kind of flea.

Mill recognizes that the method of concomitant variation is really a special form of the method of difference. He writes, "It is scarcely necessary to say that in order to ascertain the uniform concomitance of variations in the cause, the same precautions must be used as in any other case of determination of

an invariable sequence. We may be warranted in inferring causation from concomitance of variations, the concomitance itself must be proved by the mehtod of difference."[17]

5. Method of Residues: Mill says that after certain causal connections are discovered, there remain factors, cause of which are not known and the method of residues is devised to deal with such residual factors. He states the method as follows, "Subduct from any phenomenon such part as is known by previous inductions to be the effect of certain antecedents, and the residue of the phenomenon is the effect of the remaining antecedents."[18]

We can understand it by an example. Suppose A,B,C is followed by a,b,c; B is known to be the cause of b and C is known to be the cause of c; therefore A is the cause of a.

This is not really an independent method, since the precise nature of causal connection between the residue of a phenomenon and the residue of antecedents would have to be determined by some other method. The greatest value is in the fact that it brings to light causal connection which would not otherwise be suspected to exist. It often informs us of "sequences in which neither the cause nor the effect were sufficiently conspicuous to attract themselves the attention of observers."[19]

There are some remarkable examples of discoveries made by this method. Mill has given an illustration for this method, the discovery of planet Neptune by Adams and Leverrier. "The motion of the planet Uranus has been studied with the help of Newton's theories: Its orbit was plotted on the assumption that the sun and planets within the orbit of Uranus were the only bodies, which determined its motion. But the calculated positions of Uranus were not in agreement with the observed position. On the assumption that these differences could be explained by the gravitational action of planet. Outside the orbit of Uranus, the position of such a hypothetical planet was calculated from purturbation in the motion of Uranus. And in fact the planet Neptune was discovered in the vicinity of the place calculated for it. This achievement is credited to the method of residues."[20]

Here we can see that this Method of Residues is in fact a deductive method in disguise; it is not genuinely inductive. Suppose a is preceded by x,y and z, and so we search for the cause of a in the set of x, y and z. We know already that neither x nor y is the cause of a, and therefore take z as the cause of a. This argument has the following form.

a is caused by either x or y or z

a is not caused by x

a is not caused by y

Therefore a is caused by z

This argument is purely deductive. But since the first premiss is generally suppressed, this type of argument gives an appearance of being inductive.

Thus there are altogether five methods which are not equally fundamental. The method of agreement and the method of difference are the two fundamental methods and the rest are only modifications of these two. According to Mill these methods are valuable in the process of attaining truth. Even where these methods may fail to eliminate all irrevelant circumstances they enable us with some degree of approximation to establish the conditions of the occurrence of a phenomenon. So we can say that one hypothesis is logically preferable to its rival.

Thus J. S. Mill tried to justify induction by postulating the law that every event must have a cause. This is the law of universal causation. Mill says that this law could be trusted because in all experiences it was never refuted.

DAVID HUME ON THE PROBLEM OF INDUCTION

All modern discussions of the philosophy of `Induction' starts from Hume's analysis of `Causation'. Between Bacon and Mill came Hume. Hume does not use the words `Induction' or `Inductive' in his writings. He speaks of argument or inference or reasoning from experience or from cause and effect or even concerning matter of fact. The arguments which he discusses under these headings will all be called `Inductive'.

Hume, unlike such later writers as J. S. Mill, is not satisfied to analyse the notion of cause and effect into notion of contiguity, temporal succession and joint occurrences. Hume discusses along with these the criterion of necessary connection. How can we get knowledge of anything except what is happening at the present moment ? How do we know that the particular laws of nature which are true today will continue to do so tomorrow or next year ? This is the problem of Induction which was first raised by David Hume. Hume does not show that inductive method is false but that its validity cannot be established and all possible lines of proof seem unpromising.

Hume raises the `problem of Induction' by analysing the concept of Causation. He says that all inferences from the existance of one object to that of another are non-demonstrative

and based on the relation of cause and effect. He says "All reasoning concerning matter of fact seem to be founded on the relation of cause and effect. By means of that relation alone we can go beyond the evidences of our memory and senses".[1]

Hume is chiefly interested in the propositions which go beyond our immediate present perceptions and memories. According to him the things named as causes are so various that there is no quality by virtue of which a thing may be called a cause. He says all general beliefs are based on causal connections.

The origin of the idea of cause and effect is not to be found in our perception. It must be derived from some relation among objects. Cause and effect are contiguous in space and time,and the cause is always prior in time to the effect. For example when an ordinary man observes a constant conjunction of A and B in repeated instances where A is contiguous with B and is prior to B, then he infers that A is the cause and B is the effect. In this way according to Hume Contiguity and Succession are essential for causation.

When Hume includes contiguity in causation he does not mean that we require every cause to be contiguous with its effect, but merely means that where this is not the case, cause and effect are thought to be joined by a chain of intermediate items, where each such item is the effect of its predecessor and

cause its successor, and is contiguous with both of them. Hume gives an example of a billiard ball, which is lying on a table and another ball moving towards it with rapidity. The ball which was lying on the table now acquires motion. According to him "It is evident that the two balls touched with one another before the motion was communicated, that there was no interval between the shock and motion". Further he argues that "It's evident likewise that the motion, which was the cause, is prior to the motion, which was the effect. Therefore contiguity in time and place is a requisite circumstance to the operation of causes".[2]

Regular succession is another acceptable feature in Hume's theory of causation. According to him Regular succession means that if we know that C type of events are always followed by E type of events and E type of events are always preceded by C type of events, then on observing C we can validly infer that E will follow on observing E we can validly infer that C has preceded. This is a regular succession between C and E.

As regards the relation of temporal priority Hume appeals to what usually experience confirms. He says that "an object which exists for any time in its full perfection without producing another is not its sole cause". Hence "If any cause may be perfectly contemporary with its effect, 'It is certain according to this maxim that they must all of them be so". Again if one cause were contemporary with its effect and this effect

with its effect and so on, "It is plain there would be no such thing as succession".[3]

According to Hume, over and above contiguity and succession there is another important element in the idea of causation, the idea of necessary connection. He says that "there is a necessary connection to be taken into consideration, and that relations of much greater importance than any of the other two above mentioned".[4] Necessary connection is the defining characteristic of the causal relation.

Hume holds that the idea of necessary connection among events arises from our experience of a number of similar instances which occur in constant conjunction. After a repetition of similar instances, we habitually expect one thing, by the appearance of another and believe that it will exist. The customary transition of imagination from one object to its usual attendant is the impression from which we form the idea of `power' or necesary connection.

For Hume, a cause and its effect require the existance of the one to be entailed by the existence of the other. If so, it does not need much argument to show that we can have no impression (direct sensory experience) of such entailment. He says that necessity cannot reside in the external world but must arise as an idea from an internal impression.

He argues that impression cannot yield the relation of necessary connection. In the example of billiard balls, all that we see is that one ball strikes the other and the other moves. But we never perceive any power in one passing to the other. Hume points out that necessity is something that exists in mind, not in object. According to him either we have no idea of necessity or necessity is nothing but a determination of thoughts to pass from cause to the effect and from effect to the cause.

According to Hume, to understand the idea of necessary connection we should find out the answers of the following two questions:

1. Why do we believe that `Every event must have some cause ?
2. Why do we believe that the same cause must necessarily produce the same effect ?

It is said that `Every event must have some cause' is the universal principle of causation. According to Hume, we can never establish this principle either by demonstration or by intuition.

Hume argues that this maxim can never be demonstrated true by any argument. If it is demonstratively true that every thing that begins, must have a cause of its existance; then it will be absolutely impossible for something to begin to exist

without a cause. But he says that it is not absolutely impossible for some thing to begin to exist without a cause for the following reason.

All distinct ideas are separable from each other. The idea of A's beginning to exist is evidently distinct from the idea of a cause of A's beginning to exist. Therefore we can separate one idea from the other in the mind. The denial of this maxim is not self-contradictory, so it is not demonstratively true.

Hume tells us that this maxim that `whatever begins to exist must have some cause' is not intuitively certain. He thinks that anyone who will refute this conclusion that `whatever begins to exist must have some cause' is not intuitively certain, must exhibit a relation which will be identical with causality and knowable by direct inspection. But the causal relation is not known by direct inspection. Therefore according to Hume the causal maxim is neither demonstratively certain nor intuitively certain.

In relation to the second question `why do we believe that the same cause must necessarily produce the same effect, Hume says in the `Treatise' that only by experience we can infer the existence of an object from another. Hume explains the nature of experience as follows:

"We remember to have had frequent instances of the existence of one species of object; and also remember that the individual of another species of object have always attended them and have existed in a regular order of contiguity and succession with regard to them. Thus we remember to have seen that species of objects we call flame, and to have felt that species of sensation we call heat. We likewise call to mind their constant conjunction in all past instances. Without any further ceremony, we call the one cause and the other effect, and infer the existence of the one from that of the other".[5]

Thus contiguity and succession are not sufficient. It is the relation of constant conjunction which produces the mental habits of regarding things as necessarily connected. Now on the basis of past experience and rememberance of the constant conjunction, we think of a necessary connection between cause and effect.

According to Hume every effect is a totally different event from its cause. Therefore it can never be discovered in the cause. From the fact that a particular sort of cause has always been followed by a certain sort of effect, it cannot validly be deduced that it will be so again. Constant conjunction is the constant repetition of impression and ideas conjoined in space and time. Hume says that "We cannot penetrate into the reason of conjunction, we only observe the thing itself and

always find that from the constant conjunction the objects acquire an union in the imagination". Hume makes it clear that "We have no other notion of cause and effect, but that of certain objects, which have been always conjoined together, and which in all past instances have found inseparable".[6]

By the association of ideas we infer that a particular cause will always be followed by a particular effect. If experience shows that A's have been frequently followed by B's and never to have occured without B, the idea of B is associated with A in a way in which no other idea is. As a result when the idea of `A' occurs, mind is determined to pass to the idea of B and to form the idea of B. Determination of mind solely depends on repetetion of past conjunction; and not on any reasoning.

Hume says that after the constant conjunction of heat and flame, we expect the one from the appearance of the other, only due to habit or custom. Hume writes "All inference from experience therefore, are effects of custom, not of reasoning. Custom, then is the great guide of human life.....Without the influence of custom; we should be entirely ignorant of every matter of fact beyond what is immediatley present to the memory and senses".[7]

The feeling of determination to which Hume traced the idea of necessary connection is not the same as the feeling of

belief. Determination carries the mind from the idea of the cause to that of the effect, as well as from impression of the cause to an idea of effect. All belief of the matter of fact or real existence is derived merely from some object, present to the memory or senses, and from a customary conjunction between that and some other object. For example we have seen that snow and cold have always been conjoined together. If snow is present then due to habit we will expect cold and have belief that such a quality does exist. According to Hume "Belief is something felt by the mind, which distinguish the idea of the judgement from the fiction of the imagination".[8]

Hume asserts that all reasonings concerning matter of fact are founded on experience and all reasoning from experience are based on the supposition that `Future will be like the past'. Thus we conclude that the same cause, in same circumstances, will always produce the same effect. Hume says that we have no justification for believing that things will continue to behave as they have behaved. We do believe this and act on this suppostion as a matter of animal habit and there is no justification for our doing so. Hume claims that we cannot give any justification for our inductive inference. Hume says:

"You must confess that the inference is not intuitive; neither is it demonstrative; of what nature is it, then ? To say it is experimental, is begging the question. For

all inferences from experience suppose, as their foundation, that the future will resemble the past, and that similar powers will be conjoined with similar sensible qualities. If there be any suspicion that the course of nature may change, and that the past may be no rule for the future, all experience becomes useless, and can give rise to no inference or conclusion. It is impossible, therefore, that any arguments from experience can prove this resemblance of the past to the future; since all these arguments are founded on the supposiiton of that resemblance".[9] According to Hume only on the basis of past experience we make the inference that future will be like the past.

Uniformity of Nature is the fundamental principle of the whole process of inductive reasoning. Unless we have reason for accepting this supposition that future will be conformable to the past our inference will not be justified. How can we justify this principle of Uniformity of Nature ? According to Hume it cannot be justified either by probability and experiences nor by apriori and deductive analysis.

It cannot be justified by probability because probability rests always on causal relation. Our knowledge of that relation is derived entirely from experiences, and all the experimental conclusion proceeds upon the supposition that the future will be conformable to the past. Therefore the proof of this last supposition that future will be conformable by probable argument

involves a circle. So this principle cannot be known by probability.

Hume's criticism is that if we attempt to justify this principle of Induction (i.e. the principle of the uniformity of Nature) we are bound to commit the fallacy of petitio principii. In this argument the very basis of inferring the conclusion from the premiss is our assumption that the `future always resembles the past' which is the proposition to be proved.

The principle of the uniformity of nature cannot be proved apriori. If this principle is apriori then the negation of this principle should be self-contradictory . But this is not so, because it implies no contradiction to say that the course of nature may change or that the objects which look like those which we have experienced, may be attended by different effects. For example, it is a sort of law of nature that the sun rises daily but its denial (as implied by the proposition that the sun will not rise tomorrow) implies no contradiction. Although it will be strange to think of it, but it is not impossible.

According to Hume we cannot prove the principle of Uniformity of Nature by experience either. All inferences from experience presuppose as their foundation that the future will resemble the past and similar power will be conjoined with similar sensible qualities.

If there is any doubt that the course of nature may change and the future may not resemble the past, then experience cannot give rise to inference. Therefore it is impossible that any argument from experience can prove the principle of the uniformity of nature.

Hume says that we cannot give any deductive justification to this principle. If we do so, we will have to assume such principles which are intuitively or demonstratively certain such as the principles of mathematices, logic, etc. Here we cannot use these principles because they are truths concerning relations between ideas. By these principles we can never prove the truths concerning matters of fact; and the principle of the uniformity of nautre, being about the constitution of the world concerns matters of fact.

Acording to Hume there is no such factual principle by which we can prove the principle of the uniformity of nature. Even if we assume any such principle, the question about its own justification will arise. For the justification of that principle we will have to assume another principle and so on ad infinitum. Thus we will be caught by infinite regress.

Hume concludes that there is no justification for the principle of the uniformity of nature. All inductive reasoning is based on this principle and we have no justification for it;

therefore principle of Induction also cannot be justified.

In this way Hume raises the problem of justification of Induction. Various solutions have been given for this problem by different philosophers which will be taken up in the following chapters.