AN 'INTELLIGENT' MACHINE?†

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Modern miniaturised digital electronic systems allow the construction of entities that can engage in such activities as assembling other machines, serving as extensions of lost limbs, carrying out given orders, choosing components by touch/feel and making optical judgements of texture for assembly, even executing surgical procedures, etc. that outwardly resemble mental activity, conscious and considered, 'intelligent' but 'artificial'. In the living mind there seems to be an awareness of something beyond the 'task at hand' and, if I interpret the first stanza of the Kenopanishat *right, the composers of Upanishads seem to have been capable of isolating and seeing the 'clinging' nature of awareness that includes self-awareness. They raise questions but refrain from any sort of assertive answers, apparently suggesting that in an openended situation there cannot be any answers. This is in line with the position that there was no 'design' in Evolution that has been flailing to fill all niches that opened up in front and retreating where they closed behind, taking its time, without purpose, apparently an endless process. When an artificially constructed 'intelligent' machine successfully fulfils its purpose it meets its terminus when the natural 'mind' seemingly does not meet such a fate.*

Maybe the title of this article should be changed to 'An Intelligent (?) Machine'! But then, the very name of one of the Upanishads, *Kenopanishad*, which I quote in the main body of this article, is interrogative and I decided to keep the title as it is now.

Preliminary

Following is a reproduction of an interview given by Professor Roger Penrose during his visit to Bangalore in December 1997 to the science correspondent of a prominent newspaper. The report of the interview begins with a quotation from Professor Penrose's famous book and tells us who he is:

Consciousness seems to be such an important

phenomenon that I simply cannot believe it is something just 'accidentally' conjured up by a complicated computation.

From *The Emperor's New Mind*
by Sir Roger Penrose[1]

Sir Roger is a Professor of Mathematics at the University of Oxford, UK. In 1990, he was awarded the Einstein Medal and has written several famous books. His publication include: *Techniques of Differential Topology in Relativity* (1973), *Spinors and Space-Time* and *The Emperor's New Mind* (1989). He has also worked with Stephen Hawking and has co-authored a book with him. He was on a visit to Bangalore to deliver a lecture at the J. N. Tata Auditorium, Indian Institute of Science. His talk was entitled, 'Science and the Mind'. Later he explained his scientific thoughts in an exclusive interview given to the newspaper.

Most of your books negate the theoretical probability of a computational device achieving intelligence. Would you explain your stand?

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Awareness or understanding is necessary for true intelligence, or genuine intelligence. Intelligence achieved by a computational device is only partial, and not the real thing. There are mathematical arguments that go to say that 'mathematical understanding' is not computationally based.

Can you comment on the recent victory of IBM's 'Deep Blue' with Gary Kasparov in a chess game?

Chess positions are easy for a human being because they are based on 'understanding'. Some moves are obvious. A computer can probably play good chess but cannot 'understand' what it is doing although it may do it much faster than a human being. But a computer can only 'offset' understanding by brute-force computation. In fact, the computer relies on human understanding (its own programmer) to play a game of chess!

You say that consciousness is 'non-algorithmic'. Is there any theoretical reason why a robot cannot be functionally intelligent without being 'conscious'?

Some things can be done well without understanding. However, 'judgment' is so abstract and requires consciousness. Naturally, learning cannot be tested objectively. In my opinion, a robot functions at the expense of intuitive qualities.

You mention that a new type of quantum mechanics is needed to explain brain functioning. Can you explain this?

The brain, in my opinion, acts according to physical principles similar to those governing the rest of the universe. Laws of quantum mechanics are also relevant to our brain functioning. An important area in physics where we are missing is a 'measure problem' in quantum mechanics.

Schrödinger's cat[2] may be half dead to some and half alive to others. It is non-computable, at that level. The consciousness of the mind is involved here. So also is the gravitational effect of the system as well as electromagnetic force. There is a conflict of principle here. Also the time (d/dt) of a large system has to be taken into consideration. There is a conflict of time for the cat at one position and another position. For example, take a crystal. The superposition of two bodies is unstable in a time state and depends on the gravitational pull. This is actually quantifiable now, using the techniques available………..

Introductory

As I finished reading, with great interest, this report and an accompanying article, I could not help but wonder whether modern Indians (e.g. the correspondent of the newspaper, workers in the field of 'artificial intelligence', etc.), dazzled as they are by the technological achievements and prowess of the West, will ever remember (or rather, get to know) what relevance ancient Indian thought may have to the question: Can one construct an 'intelligent' machine?

We can all agree, I think, that inducing 'consciousness' is a prerequisite for building a truly 'intelligent' machine. As we just saw, Roger Penrose expresses profound skepticism about inducing 'consciousness' in a machine when he says, "I simply cannot believe consciousness is something just 'accidentally' conjured up by a complicated computation". We are free to wonder, in our turn, "If the building of 'consciousness' is not an 'accident,' is it the result of a *programmed* biological evolution"?

Upanishadic Times

Going to early times, the *Kenopanishat* (literally, *kena* - "By whom"; *upa-nishat* - "sit beside me"!) begins with the question, "*keneshitam patati preshitam manaha*? ...", which Sri Aurobindo translates as "By whom missioned falls the mind shot to its mark?" using the imagery of an arrow or a bullet aimed and shot to its mark[3]. Another translation (of the first few *slokas*) reads: "By whom willed and directed does the mind alight on its objects? By whom commanded does the *praana* (the breath), that precedes all, start? By whom willed do men utter speech? What intelligent power directs the eye to see, the ear to hear ......?"

It is not important whether the composer of the Upanishad (or anybody else, for that matter) provides an answer ultimately but the imagery is significant. The root *ish* [which occurs twice in the quotation - *kena-ishitam* (by whom flung) and *pra-ishitam* (directed)] can also take on the meaning 'to cast or to throw'. The imagery is then one of a fisherman casting a net: "By whom directed and cast does (the net of) the mind fall?" showing the clinging, all-enveloping or associative (or sticky), character of mental activity.

What is 'Definition'?

Speaking of the 'clinging or associative nature of mental activity', the Indian Ancients, much interested in linguistics, researched certain principles grouped under the head *Shaabdabodha*[4] and looked deeply into the 'philosophy of a sentence and its parts'. One of those principles can now be clearly seen as having anticipated a part of the analysis behind modern, 'knowledge-based,' computing. An expression like "A brown dog"[5] creates

certain associations: 'pet animal', 'four-legged', 'snout and tail', 'tall/short/long', etc. with further associations like, 'warm mammal', 'canine teeth', 'friendly/faithful', 'lolling tongue', 'bent/wagging tail', 'brown fur', 'rabies' and so on, with the additional complication that the dog, like man, is a polytypical animal, varying from a chihuahua to a great dane. The 'computer chaps' try to perform 'knowledge-based' processing for activating "Artificial Intelligence" but are soon confronted by the question: "What constitutes a 'definition' (or, in what way can definition be related to fuzzy logic)?" Does it involve the creation of ever-increasing numbers of associations whenever an expression is uttered and heard? Can you meet the challenge posed by those associations orbiting around an expression in ever-expanding circles of decreasing relevance just by setting up a data base and writing programmes which search for as many associations as possible?

It is known that the Microsoft people at Redmond (near Seattle, USA) are attempting to do precisely that but in a confined way - looking for as many sets of associations of typed-in expressions as may be needed for some specified purpose (be it retrieval from the 'closed universe' of several thousand words in the *Oxford English Dictionary* or making an attempt at the none-too-trivial a task of automatic (machine) translation, and so on). But would those 'cyber geeks' ever acknowledge that the principle behind their efforts has been anticipated by more than a millennium by Indian Ancients who had, perhaps, seen the futility of it all?

"General Knowledge"

It is somewhat unfortunate that no competent reviewer has compared Penrose's books with Bertrand Russell's *Of Human Knowledge - its Scope and Limits*, written in the 1940's,[6] much before the advent of electronic digital information processing, "Artificial Intelligence" (or, for that matter, PC's). Russell speaks of the problem of what he calls, with a specific connotation, 'General Knowledge'. Everybody understands a 'general' statement like, "Copper conducts electricity", the 'associations' being 'metal/kettle', 'shiny red', 'wire', 'electric shock', etc. Everybody also understands the difference between that statement and what appears even more general: "All copper conducts electricity", a statement that merely emphasizes the uniform properties of a given material of one kind. I put the question relevant to this difference to the cybernetist Norbert Wiener during a question-and-answer session after he had delivered a popular-level talk during a visit to the Indian Institute of Science, Bangalore, back in the middle 1950's during the days of "main frame" computers: Can computer engineers

['cyber geeks' nowadays!] meet the challenge of building a machine that 'understands' the difference? Wiener's answer appears in the next paragraph.

The computer chaps deserve credit for trying to look into the 'art of the possible' with whatever is available to them - a *machine*. The machine needs what can be called a process of 'verbalization' [A better word than 'concretization'?] through which it can be made to prompt: "Put the sample at position A". It will then go through a routine of measuring the properties of the sample, as it has been made to, and compare them with what has been placed in its 'knowledge base.' It will pronounce the sample to be copper if it has the atomic weight, the isotopic distribution, the conductivity and chemical properties of Cu, etc. Has 'general knowledge' been created? The software (the program, the algorithm, or 'whatchummacallit') the computer chaps wrote couldn't have amounted to anything more than setting up a train of intricately meshed gears. The processor, be it an extensive 'learning system' with 'educable neural networks' (called so after Alan Turing[7]) or one that operates on the 'principles' of "fuzzy logic," engages those gears with *its* own pre-existing set in order that it is able to perform the way it has been asked to perform.

'Literalness' of Machine Processes

The 'literalness' of machine processes makes one ask, "Were both the Ancients, who worked on aspects of *Shaabdabodha* in their time, and the computer chaps working with 'knowledge bases' now, committing an error in presuming, apparently, that the mind works by 'verbalizing' associations? Would such 'verbalizing' amount to anything more than putting one expression into other expressions?" Can you say that the machine 'understands' anything at all, even after getting at a large number of associations? Seeing associations of any expression could be akin to letting the wave function collapse[8]. [I take recourse (and the liberty) to borrow from the language of Quantum Mechanics here since it conveniently expresses what I wish to say. I am not suggesting that mental processes are akin to processes of Quantum Mechanics in some way.] Since associations are virtually limitless, the collapse can take place in a thousand different ways - Schrödinger's famous cat has many choices of things to do besides being alive/dead. There seems to be in us, in one aspect of our 'understanding' at least, some sort of "fading into the distance" of the more remote associations - an effect Alan Watts[9], the well known author of subjects Buddhistic, compares with focused and peripheral vision - a 'something' that could amount to keeping certain sensorial

inputs in an 'uncollapsed' condition. The lack of 'border' between what is in focus and what is outside it does not limit our ability to 'understand' an expression. Openendedness of this sort will defeat all attempts at creating an 'understanding machine', however, because a machine will always demand sharp delimitation of the 'border' in order to be able to complete its mechanical task in some 'intended' fashion! The wave function must be collapsed *before* the machine can get at something concrete to work with. Not so the case, apparently, with mental activity. There is in all of us an awareness of a non- or pre-verbal generative process when we hear a word (or receive any sensorial input) or utter something in words (or indulge in any action). The mind seems capable of keeping the wave function in an 'uncollapsed' condition until something 'concrete' needs to be done.[8]

Biologic Panorama

'Ahankaara' and the vedantic concept of "I", "I"-ness and consciousness

Yes, our Ancients were also concerned with the question of 'satisfaction,' the sensation one gets when one hears the statement: "Three plus two is five" and 'sees' that it is 'correct'. The Ancients would have said that that sense of satisfaction has something do with one's *ahamkaara* ("I"-ness or *aham bhaava*, the "I"-feeling at the basis of the sense of satisfaction). Can that feeling of "I"-ness be built into a machine? I now quote indirectly, and in parts, a well-written newspaper feature[10] that neatly encapsulates some of the ideas of Shankara (the *Aadi* Shankara, usually dated to the 8th century CE): The Upanishads basically speak of a life-giving force that resides in everything in this Universe, sentient or otherwise. In his magnificent work, *Vivekachudamani*, Shankara speaks of the pervasiveness of this force: 'Every living being identifies itself as 'I', like 'I am so and so', 'I am the owner of this object', and so on. Who or what is this 'I'? Is it the body, is it a mental process of identification, or what else is it? Shankara says that there is something that is the substratum of this 'I' consciousness, an indefinable 'something' that imparts the awareness of 'I' to the being, the awareness of the 'ego'.

We are free to wonder if Shankara would have disagreed if someone had said "Plants get born, live and die. They must have some form of *ahankaara*". One may conjecture that in the earliest probiotic systems[11] (on a clay surface "in some warm little pond", as Charles Darwin said) there came about a molecular arrangement that annexed, and made part of itself, some "lesser" molecular system, even while eliminating some unacceptable parts of the latter.

Did the former have a sense of itself and "knew" what it was doing: "I" eat this food while excreting some unwanted parts?

"Sessile" vs. "Vagile"

These two terms (*sessile* – staying in one place, *staavara*, and *vagile* – having the ability to move about, *jangama*) may not quite serve to distinguish clearly and fully plants from animals. Based on his investigations of their inner activity the great polymath Sir Jagadish Chandra Bose used the term 'sessile' while reporting how "sentient" plants are. While the details of Sir JC's research/conjectures on 'memory, learning, intelligence' in plants, commented on and well-reported in many references,[12] cannot be gone into here one may note that since his days a great deal of progress has been achieved in matters connected with propagation of information in living organisms. To list a few important ones, developments have taken place in instrumentation (microprobes, micro transduction elements, "billion-fold" *digital* amplification of effects induced by stimulus, insult (injury) etc., caused to living entities), understandings of modes of information propagation/ processing by the examination and, in some cases, the determination of the structures and specificities of chemical and electrical/ionic channels in and across cell membranes, and so on.[12] Sir JC measured the rapid increase in cellular calcium (Ca^{2+}) and the velocity of propagation of the generated action potential in *Mimosa* ("touch-me-not") in the mechanically perturbed cells using only his "homemade" instruments. I am not aware of any reports of Sir JC's investigations having been repeated using the newer instrumentation in order to confirm (or refute) his observations and demonstrations. And, I do wonder what wouldn't he have achieved had he command of such instrumentation.

Information Processing

Information processing is demonstrably as complex in *sthaavaras* as in *jangamas*. Where does a difference lie? Among the most significant differences in structure that "crept in" into the changes that "Life on Earth" was undergoing over the eons ("….but the universe does not seem to be short of time…" – N. W. Pirie[11]) has been the gathering of sensorial apparatuses at the front ends of the *jangamas* (except those involved with the senses of touch/ pain/heat/cold) and the, perhaps increasingly necessary, structural development of a "centralized processing unit" - CPU. The question now arises whether the *sthaavaras* can 'make-do' without a CPU comparable to the ones found in the *jangamas*. They do, in a sense, in that the activity in a *whole* plant may be taken as broadly resembling the activity

of a 'simple' brain. An important difference lies, however, in the modes of transmission of information in the two types of entities, primarily ionic/chemical transport (enzymic, hormonal, etc.) in *sthavavaras* and the added-in processes associated with what may be described as 'electrical conductivity' in the case of the *jangamas*. The latter require that the axons, the long projections from nerve cells (neurons), be connected to post-axon structures (dendrites, for one) through synaptic junctions where direct electrical transfer or, more importantly, triggering and transfer of neurotransmitter molecules available from a host of such molecules; maintenance of such activities requires that axons, synapses and related structures be electrically insulated by a 'fatty' sheath (myelin – a fat-protein complex). Though based on broadly similar biochemical reactions this difference has been maintained through the course of Evolution.

We must also be aware that Evolution is punctuated by numerous instances of changes either internal (successful predation of one species by another, parasitism, epidemic disease, etc.) or external (climate change, asteroid/comet hits, genetic changes induced by natural radiation, etc.) causes. Additionally, anthropogenic causes may be initiating further changes.

Mental Activity Needs Physical Feed

There is a long-standing and important tradition in the West of attempting to look for and attempt to construct mechanical analogies of biological processes. At one level, the eye is thought of as so 'designed' that it can be compared with a camera or the ear with a microphone (or vice versa!). At a much higher level of understanding are the processes associated with transmission of genetic information the analogy here, complexities aside, being a basic 'reading' of the genetic 'tape'. The Moderns are in a position to challenge the Ancients thus: admit that mental activity has, after all, a physical basis - mental activity stops when electrical activity in the brain, mediated by biochemical reactions, ceases at death. Can one not find a "seat" of the mind ("mind" in the broadest sense – *manas*), somewhere between the eyes (the "third eye"[#]) ? The small pineal gland, situated at the lower center of the brain, has been a favourite spot with such thinkers as René Descartes.[13] Investigations since his time have shown the gland is just one endocrine organ among many. It produces melatonin, a hormone which modulates sleep pattern cycles. A great deal has been gained in understanding and mapping

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\# This is not to be confused with Shiva's Third Eye which has an entirely different connotation.

various chemical and electrical events in the brain, in the events that follow when the retina receives falling light, for example. However, how such activity manifests itself as an image and how that image gets related to certain contexts and memories is far from being described/understood. That mental activity ceases at death is the reason for the optimism that, given sufficient number of interacting (well-fed!) neural elements (even artificial ones), comparable in number with what is found in living systems (something like 14,000 million in an adult human brain), "mind" ('construction' of the image plus self-awareness) will manifest itself.

Those who eagerly broker a marriage of quantum theory with gravitation, in a desire to let a Theory of Everything gambol on a Unified Field, appear not to have seen a way to include what goes by the name "Life". On a rather mundane plane they can set up a quantum computer. But they would only be constructing what will turn out to be, eventually, a machine. Even the optimists among them would find that they may not, after all, be able to induce *aham kaara* into it (notwithstanding Arthur Clarke's imaginings of a computer that exhibits *aham kaara*, and engineers a murder, in his sci-fi novel *2001 - A Space Odyssey*!).

Those who are now struggling to lick problems of Internet security (or earlier with the silly Y2K problem, fixed with highly lucrative results, no doubt!) will find that they can make a machine that can carry out only literal tests. If the answer on adding three to four is identical with seven, through an operation programmed-in earlier, the machine can be made to pronounce: The statement, "Three plus four is seven" is 'correct'. It can do nothing to show that it has 'understood' the matter the way a teacher may become 'aware' that the child has 'understood'..

If you ask, now, "Does the 'depth' of the difficulty in machine-representing what is called 'knowledge' or 'understanding' have anything to do with the nature of matter or with the 'design' of creation?" you will hand me a chance to tell you: Even while matter is the basis for constructing a machine or writing a program, the very whiff (*vaasanaa* in Sanskrit) of 'design' will destroy openendedness since 'design' immediately implies a purpose; executing it means reaching some kind of terminus – even a biological organ, the eye for example, photosensitive, fully accomplishes the job it is 'designed' for when it sends its gathered data through the optic nerve. Does gaining knowledge and understanding (or biological

evolution that created the human brain, for that matter) operate in any programmed way, 'designed' for something?

Would asking the composer of the *Kenopanishad* to rewrite his/her opening line as "By whom was all this programmed?" have any meaning? If 'all this' were the 'result' of some programming, we might never have wanted to formulate that question, not having been programmed that way! Does there not having been, ever, any programming necessarily mean that 'all this' could only have been accidental? Or, is there something, neither 'accidental' nor 'programmed,' that is beyond verbal description or 'understanding'?

I wish to end by quoting two eminent Western scientists: "The laws of nature, insofar as they are known, "are impersonal, with no hint of a divine plan or any special status for human beings. I struggle with the necessity of facing up to these discoveries."- Steven Weinberg in "Facing Up: Science and *its* Cultural Adversaries." This could be described as theistic anguish. Or, was there no room for anguish: there was 'design' in Evolution and it was to create 'mind', 'knowledge' and 'self-awareness'. But then, we can ask: why has Evolution been flailing over aeons of time in its attempt to fill all niches that opened up in front and retreated where they closed behind, seemingly without purpose?

A more impersonal statement, less concerned with "faith", is due to the British scientist Richard Dawkins: "The universe we observe has precisely the properties we should expect if there is, at bottom, no design, no purpose, no evil and no good, nothing but blind, pitiless indifference". This statement has been described as one of the most existentially penetrating ever made by a scientist.

Those who "understand" the Upanishadic thinkers will not suffer from Weinberg's anguish nor will they be worried about that "pitiless indifference". I have found the following quotation from "The King and the Corpse", a retelling of *Vikrama and Vetala* by Heinrich Zimmer,[14] hits the mark: The involvement of the gods in the web of their own creation, so that they become the harried victims of their creatures, entangled in the nets of not quite voluntary self-manifestation, and then mocked by the knowing laughter of their own externally reflected inner judge: this is the miracle of the universe.

I have adapted this figure from a similar one in Penrose's *The Emperor's New Mind*[1] where he seeks to illustrate important relationships. I have redone those interrelationships by trying to connect them in a Maurits Escher fashion. I have placed a mark of interrogation in the center to symbolize the question: how does a feeling of *ahankaara*, basic to the identity of everything that lives, get built-in, for example, in a protozoan that is able to identify non-self *viz.* food.

Is looking for a 'plan' a disease of the human mind?"

References

1. R. Penrose, *Emperor's New Mind*, Vintage, New York, 1990.

2. Unless the wave function 'describing' the cat is 'collapsed' by an observation it is in an alive/dead condition (see later text). For an excellent, highly accessible, description of what Schrödinger's pet pet does see: Paul Davies, *Other Worlds*, a Touchstone Book, Simon and Schuster, New York, 1982 (paperback edition), pp. 130 ff.

3. *Eight Upanishads*, Sri Aurobindo Asram, Pondicherry, 1953.

4. An excellent sourcebook on *Shaabdabodha* is the book *The Philosophy of a Sentence and its Parts*, the published version of the Ph. D. thesis of Dr. Veluri Subba Rao (Munshiram Manoharlal, New Delhi, 1969). The title in English reflects only part of the sense of *Shaabdabodha dhaatu naama pratyayadi artha bodha vishayaka prabandhaha.*

5. Sanskritists of old commonly used a different example, one based on the root *pach*, to cook - *ramaha pachate* - Rama cooks, with associations like, "Is Rama a cook?", "Does he cook for himself?" (note the *atmanepadi* construction of *pachate*), "Is he cooking rice?", "Is he using an iron pot?", "Is he holding a ladle in hand", etc.

6. Bertrand Russell, *Human Knowledge - Its Scope and Limits*, George Allen and Unwin, London, 1948.

7. It is instructive to read *Alan Turing's Forgotten Ideas in Computer Science* by B. J. Copeland and D. Proudfoot in *Scientific American* April 1999, p. 76.

8. *Time, Space and Things* by B. K. Ridley, Cambridge University Press, London, II edition, 1984.
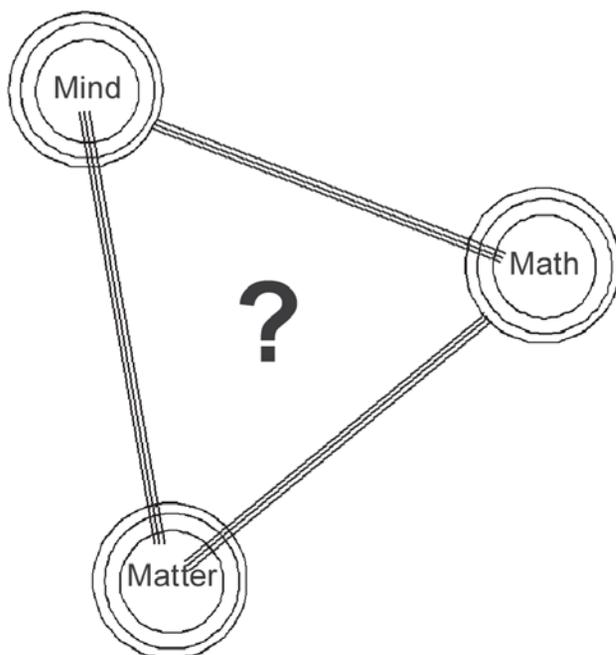
9. *The Way of Zen* by A. W. Watts, a Pelican book published by Penguin, Harmondsworth, 1962, pp. 28-29: also, pp.156 ff.

10. M. E. Karthik, Featured in *Oasis,* DH, Nov. 8, 2016, p.12.

11. S. N. Balasubrahmanyam, *Science and Culture*, Vol. 75, pp. 319-325 (2009).

12. R. Banerjee and B. K. Chakrabarti, *Physics News*, Vol. 39 pp. 57-67 (2009) and references herein; also "Acharya J. C. Bose – A Scientist and a Dreamer", Vol. 4 (1996) Ed. P. Bhattacharyya, Bose Institute, Calcutta, pp. 60–62, (1996); "Memory & Intelligence in Plants: Then & Now", B. K. Chakrabarti, J.-I. Inoue & R. Banerjee, *Science & Culture*, Vol. 74, pp. 423-432 (2008); see website: http://www.saha.ac.in/cmp/camcs/banerjee_chakrabarti_PhysicsNews09.pdf; also, *Science & Culture*, Vol. 78, pp. 169-175 (2009).

13. Search for "Pineal gland as the center of mind/soul" using any search engine.

14. Heinrich Zimmer, *The King and the Corpse*, edited by Joseph Campbell, Meridian Books, New York, 1960.