

physics experiments. It is also known that these are unstable particles (with several distinct decay channels) with a half life of the order of  $8 \times 10^{-9}$  sec. The possibility of spontaneous deposition of kaons inside neutron stars was first suggested by David Kaplan and Ann Nelson<sup>2</sup> in 1986. A feature of strongly interacting sub-atomic elementary particles, which goes by the name of chiral symmetry, stipulates that kaons have a net attractive interaction with neutrons and protons that is proportional to the baryon number density. This interaction is equivalent to a density-dependent mass of the kaon, and is such that it effectively lowers the energy of the kaon in the matter. Once the  $K^-$  meson energy comes down to the electron chemical potential, which increases with increasing density, the electrons change into  $K^-$  mesons and neutrinos through the reaction  $e^- \rightarrow K^- + \nu$ . This is estimated to occur at a density  $\rho_c \sim 3\rho_0$ , where  $\rho_0$  is the equilibrium nuclear matter density whose value is about  $2.8 \times 10^{14}$  g cm<sup>-3</sup>. Above the density  $\rho_c$ , the  $K^-$  mesons condense into a zero momentum state. Although kaons made on earth in particle accelerators are very short-lived, kaons in neutron stars would be stable by virtue of their attraction to nucleons. Roughly as many protons as neutrons will be present because the charge carried by the former can be neutralized by the negatively charged kaons. As a result, the collapse remnant will resemble nuclear matter, that is, it will be a 'nucleon' star rather than a neutron star. Nuclear matter is more compressible than neutron matter. Besides, kaons are particles that obey the Bose statistics, and so can co-exist occupying the lowest energy level without exerting any resistance against infalling

matter. These two phenomena, taken together, imply that a neutron star with a kaon condensate will have a softer equation of state than a neutron star without it. Such a neutron star, travelling the path of gravitational collapse can slide into the path of formation of a black hole if the kaon condensate is sufficient. This delayed formation scenario of a black hole, induced by kaon condensation, is the key element of the Brown-Bethe hypothesis as it allows for time for the neutrinos formed earlier during the collapse to escape from the star. Had it been a straight, classic route to black hole, these neutrinos would have been gobbled up by the black hole, and could in no way pass through the earth. It so happens that ten seconds is about the time delay that Brown and Bethe compute for the gravitational collapse to black hole via kaon condensation. The neutrino burst detected on 23 February 1987 lasted for an interval of twelve seconds. It is interesting that the two time spans are so close to each other. It is worth mentioning here that a completely different explanation of this time-spread is possible. For example, Cowsik<sup>3</sup> has attributed this to a finite rest mass of the neutrinos which will cause lower energy neutrinos to arrive later. By analysing the neutrino-induced events on the time-energy plane he finds that masses 4 eV and 22 eV fit the data best. In any case his analysis provides an upper bound of about 25 eV on the rest mass of the neutrino.

The idea of Brown and Bethe of a delayed onset of a black hole starting with an intermediate neutron star stage with substantial kaon condensation is a clever one, that is able to explain the mystery of the missing neutron star in

SN 1987A as well as the neutrino observation. However, the idea is a model assumption that looks promising, and is yet to find a general acceptance among all astrophysicists. For one thing, kaon condensation is not the only mechanism for a delayed collapse of a nascent neutron star into a black hole. A delayed formation of a black hole can possibly also happen due to other evolutionary changes in the neutron star core, such as a phase transition due to the formation of additional hadronic degrees of freedom besides neutrons and protons. The passage to black hole can also be triggered by a substantial late fallback of the ejected matter onto the neutron star. Numerical estimates of the critical threshold density for kaons to make their appearance in neutron star interiors are beset with uncertainties. The values mentioned earlier are imprecise. The reason for this is that the exact value of the chiral symmetry term is not known from particle physics theory. The possibility exists that the value of  $\rho_c$  may be estimated in future from heavy-ion collision experiments. Whatever may be the case, the SN 1987A has undoubtedly triggered a renewed interest in research on the equation of state of neutron star interiors.

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  3. Cowsik, R., *Phys. Rev. D.*, 1988, **37**, 1685-1687.
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## OPINION

### Traditional knowledge systems and western science

*D. P. Agrawal*

*Should we allow the non-literate knowledge systems developed through the millennia, transmitted through word of mouth, tested through trial and error, to vanish without even trying to verify such knowledge? In this note we plead the case of the other knowledge systems to bring them within the ambit of science.*

Today, western science is contrasted with superstition and the occult, and scientists are contrasted with primitive people. Any-

thing outside its purview becomes non-science.

It is seldom realized that traditional

knowledge systems preserve the wisdom gained through millennia of experience, direct observation, and the word of mouth.

Describing such knowledge, the United Nations University (1990s) proposal says: 'Traditional knowledge, which may be technical, social, organizational, or cultural was obtained as part of the great human experiment of survival and development.'

### Western science vs traditional knowledge

Western science imposes the contrasting categories of science/religion, rational/magical, developed/under-developed and so on. But these categories are contrived. An aboriginal leader, Kwagley (in ref. 1), complains, 'Down through the millennia, the Yupiaq produced and maintained a science and technology to support a sustainable social and economic system ... (but) at the advent of the Western society the Yupiaq ways were pronounced primitive and savage ...'

Conditioned by the linear concepts of social evolution propounded by anthropologists like Frazer<sup>2</sup>, western science tends to trace social development through the stages of magic, religion and science and thus the primitive people come at the bottom of such development.

It is common knowledge that foreign experts, consultants, go to non-literate cultures and assume that they are knowledge blanks which need to be filled in with science. Following them, our young officers and environmental experts flaunt their 'scientific' knowledge to the rural/tribal people. But cultures are never 'blanks'. In fact, the knowledge of 'primitive' people, especially in pharmacology and agriculture far surpass the Western knowledge in these fields. The renowned ecologist Ramkrishnan, humbly admitted in a recent seminar (Centre for Science and Environment, March 1997) that the North-eastern tribal ecological management practices are far superior to anything he could teach them using western science.

### Indian folklore

Let me briefly give some examples from Kumaun. Snowfall on wheat fields is considered good for the crop. Accurate time is fixed through observation of stars. In the Nanda folklore (Anthu), her curses on the pine (no plants will grow under you, no birds will nest in your branches etc.) and blessings on the oak (birds and

bees will nest in your canopy, water will be there under your roots etc.) are basically descriptions of the ecological properties of these trees. Depending upon on which part of the tree—top, middle or bottom—the crow makes its nest, the severity of the coming winter snowfall is predicted. In the Kumauni folk medicine, the semen of a local fish (*Schizothorax*) is considered a potent medicine for leucoderma which in allopathy is an incurable disease.

### Ancient geological observations

Even geological observations were made by early humans and transmitted through myths. The geological history of the Kashmir valley<sup>3-5</sup>—of the vast sea that formed and was drained out by the Jhelum—is recorded in a myth in the *Nilmata-Purana*. The braiding of the Satluj is recorded in the legend of Vashishta trying to commit suicide and the Satluj breaking into hundreds of channels—hence called Shatadru. The regression of the sea (> 20,000 yrs BP) is recorded in the legend of Parashuram who threw his parasu to push back the sea<sup>3</sup>. Their models were personalized but the observations were right. Nader explains, 'Myths in a broader, paradigmatic sense are condensed expressions of root metaphors that reflect the genius of particular knowledge traditions.'

### Folk knowledge in the western hemisphere

Goodenough (in ref. 1) has reported on the navigational skills of the atoll dwellers of western Caribbean islands of Micronesia. He says, several things stand out about Carolinian navigational knowledge. It has all the features of a practical science. It contains a massive amount of discrete information, which, in the absence of writing and reference books, has to be committed to memory. The information is highly organized in a systematic way; the different ways of organizing it provide much redundancy as an aid to recall. It involves highly abstract thinking: the compass as a set of imaginary points at equal intervals around the horizon, named for the stars and abstracted from their perceived motions, but not identical with them; the use of 'drags' as imaginary divisions of one's course of travel; the use of imagi-

nary places as points of reference to calculate 'drags'; and schematic mapping in the form of 'trigger fish'.

The same Polynesians have taught marine biologists the biology of fish populations. Johannes (in ref. 1) says, 'The native fisherman searches with his eyes and ears and he is ... more in touch with his prey and their surroundings than his modern, mechanised counterpart.' Johannes admitted that he had gained more new (to marine science) information during sixteen months of fieldwork ... than ... during the previous fifteen years using more conventional research techniques.

Bielawski (in ref. 1) finds that the most significant difference between the western Arctic and the Inuit sciences is that in the latter systems humans are placed in the space of nature and are inseparable from nature, while Arctic science does not. One has to remember that the Inuit knowledge is formed through 'doing', 'hearing about it' and 'being there'—all interactive and personalized forms of knowledge transmission.

Describing the knowledge of geese hunting by the coastal Cree people of Canada, Scott (in ref. 1) says, it is heuristically useful but not in itself sufficient to assume ... that capacities of intelligence and communication are shared by geese and humans. Hunters need to know more about what is shared and what is different, and in what measure ... Scott adds, 'Numerous studies have found that the "anthropomorphic" paradigms and egalitarian hunters and horticulturists not only generate practical knowledge consistent with insight of scientific ecology; but simultaneously cultivate an ethic of environmental responsibility that in western societies has proven elusive.'

### Summary

Thus we see that folk knowledge systems can be very demanding on human mental faculties, as also very elaborate, logical and rational—no less than western science. But western science need not judge these knowledge systems with its own yard-sticks. Folk knowledge was generated through millennia of observation and experimentation, trial and error, and is more eco-friendly a system of knowledge, in which humans are part of nature as nature is part of their being. And therefore in this system there is no exploitation of nature but a symbiotic relationship with it.

The traditional knowledge systems are perhaps better preserved in the isolation of the Himalayan region or in tribal societies. These knowledge systems need to be studied, documented, preserved – before they are lost under the onslaught of the development projects. As far as I know, except in ethnobotany, medicine and water-harvesting, not much work has been done to study folk knowledge systems in India, or even abroad.

To conclude let me quote Nader<sup>1</sup> again, the belief in the omniscience of science has been steadily gaining ground throughout this century in this culture, and operating on a core-periphery model,

in the world ... We need not idealize non-western science to make the point that there are different types of knowledge that provide valid truths of use to human kind. If a dominant science silences that knowledge, we all lose. Consider a view that includes the footprints of time: a view of knowledge in which imagination and vision can be openly checked against criticism; the myth of a single science can be seen as myth; the false separation between science and non-science may be considered as a barrier to new thinking ... Ironically, standardization, uniformity, and conformity may not provide the best possibilities for new kinds of science in the long run ...

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## SCIENTIFIC CORRESPONDENCE

### Multiple shoot formation and *in vitro* fruiting from cotyledonary nodes of *Vigna mungo* (L.) Hepper

Black gram (*Vigna mungo* L. Hepper) is an important grain legume and a good source of dietary protein which is widely cultivated in the tropics, subtropics and temperate zones of the world. The lack of an efficient *in vitro* regeneration system in this legume crop has hindered attempts to tissue culture selection and genetic transformation for crop improvement. The very few available reports on *V. mungo* are hybridization of *V. mungo* and *V. radiata* through embryo culture<sup>1</sup>, regeneration from apical meristem<sup>2</sup> and ontogeny of somatic embryos<sup>3</sup>. There is no report about *in vitro* flowering in *V. mungo*. Owing to sex reversal, conventional hybridization is rather difficult in the genus. Further, breeders often face difficulties during hybridization of tropical varieties with the temperate varieties due to the extreme asynchrony of flowering time of temperate varieties. If *in vitro* flower induction of pulses is established, the system would help the breeder for making superior hybrids within a short period. However, in *Arachis hypogaea*<sup>4</sup> and soybean<sup>5</sup> *in vitro* flowering has been achieved, but not mature viable seeds. Hence, in the present report, a highly reproducible and efficient method of nodal regeneration, *in vitro* flowering and pod formation are reported.

For *in vitro* germination of cv. *Vigna*

*mungo* vamban 1, the seeds were surface-sterilized by standard procedures and allowed to imbibe in a rotary shaker overnight. One decoated seed was implanted in each culture tube containing 15 ml Murashige and Skoog<sup>6</sup> (MS) basal medium and allowed to germinate. In all media 3% sucrose was used and gelled with 0.7% bacto agar; the pH was adjusted to 5.8 before autoclaving at 1.4 kg cm<sup>2</sup> for 20 min. Each culture tube was incubated in light-dark (16–8 h) conditions of cool fluorescent light of ca. 3000 lux at 25 ± 2°C. For each concentration 20 replicates were kept. The effect of the number of intact cotyledons and the presence of shoot tip on multiple shoot induction was studied by culturing the explants with none, one or both cotyledons intact and with and without the shoot tip. All the different types of explants were cultured on MSB<sub>5</sub> (MS medium + B<sub>5</sub> vitamins<sup>7</sup>) medium with different concentrations of 6-benzylaminopurine (BAP). The most suitable explant and cytokinin concentration were selected. For further production of multiple shoots from the original explant, parent explants were transferred to new culture medium (MSB<sub>5</sub>) after 28 days. The percentage of multiple shooting and the number of shoots produced per explant at primary culture and subsequent recul-

tures were calculated. Elongated shoots (3–5 cm) excised from regenerating explants (primary and recultures) were transferred to MSRF (half strength MS inorganic + full strength organic addenda) medium with different concentrations of IBA. The number of roots, flowers, pods and seeds per pod were counted and analysed statistically.

Cotyledonary node explants with or without cotyledons and/or shoot tips elongated after 2 days and gradually induced multiple shoots (Figure 1 a) and/or roots according to explant type, hormone and its concentration on MSB<sub>5</sub> medium. The number of attached cotyledons and the presence of shoot tip affected shoot regeneration. The number of shoots produced was greater in the explants with both cotyledons without shoot tip compared to explants with one or no cotyledon (Table 1). Explants with one cotyledon produced multiple shoots from the axis of attached cotyledon, while the other side of the node without cotyledon showed no shoot regeneration but formed callus. This result coincides with an earlier report in *Vigna radiata*<sup>8</sup>. The removal of shoot tip increased the shooting efficiency of the explants. Among the six different types of explants tested, the one with both cotyledons but lacking shoot tip was found to be the most efficient for regeneration.