abroad; an appreciable number no doubt, but in no way more than half as projected by the press. The IITs are however hard pressed to maintain their quality since up to 75% of their budgets are to pay salaries and very limited funds are left for upgrading equipment. *Some years ago I found that the annual budget of TIFR, Mumbai was greater than that of the then 5 IITs combined. Comparisons are invidious, but are they not unavoidable?*

This brings me to the Holy Trinity of Indian science. Without casting any doubt about the importance of the work undertaken by them, is it not self-defeating when the students are left to get their training in universities which have primitive facilities. The wheel is coming full circle now with organizations such as defence research complaining about the lack of adequately trained man power.

The powers-that-be in Indian science come out with brave statements such as 'there is no dearth of money in India for good science'. My experience has been to the contrary. It may take up to ten years to convince scientists-turned-bureaucrats that some technology is worth pursuing. A project on Metallorganic Vapour Phase Epitaxy, now widely recognized for its quality and versatility, which I submitted in 1979 was finally funded in 1989. By then 3 other laboratories had started working on it, attesting to the importance of the technology, but we are at least ten years behind time.

A few crores of rupees for the Holy Trinity is peanuts. One does not grudge the funding if it is related to their objectives. BARC suddenly announced in the early eighties the development of the technology for space quality solar cells – this has never been heard of since. Two laboratories belonging to the same organization and in close proximity suddenly realized the importance of X-ray reflectivity for surface studies and spent a few crores of rupees each in setting up laboratories. However, all their work is on borrowed samples because sample preparation has been overlooked!

In a poor country like India, setting up 'central' or 'national' facilities when universities are starved of funds is proving counter-productive. Three Pelletrons may have been a good 'buy' but what the electronics community required was an Ion Implanter! The last half of the 20th century saw R&D driven by solid state electronics more than any other field – the chip revolution permeated all fields of S&T relying on measurement and control. But the facilities set up have been totally inadequate.

Apart from the Trinity we have other departments such as the Department of Electronics, setting up a chain of laboratories (another empire?) around the country. The DOE, set up as a regulatory authority, perhaps had some work in the license-permit Raj of the seventies – should India have colour TV, etc. But with the revolution in modern electronics and communication, most of the work in these laboratories is redundant and they are actually looking for funding from private industry. Much of the 10% per increase in budget per year over 30 years is spent on setting up impressive buildings. Is it not time that these departments be rationalized and merged with the Department of Science & Technology?

We welcome the grand success of the NRIs, especially in S&T. They have converted their professional success into becoming entrepreneurs. But when an NRI, after funding a management centre in his own name, turns around and says that we should stop all M Tech and research programmes in IITs and concentrate on producing B Techs for the US market, it is time to question this shortsightedness and/or motives.

If the USA is shifting some of its manufacturing base outside, it is for good economic reasons. However it has come to realize that a 'service economy' is not the hallmark of a Great Power. As Padmanaban has pointed out, India has a long way to go in removing poverty, illiteracy and meeting the basic needs of food, water, sanitation and housing. Fortunately or unfortunately these cannot be done 'on-line'.

D. N. BOSE

Advanced Technology Centre,
Indian Institute of Technology,
Kharagpur 721 302, India
(e-mail: dnb@matsc.iitkgp.ernet.in)

Shrimp embryo cryobanking is now possible

For developing marine shrimp industry all over the world through aquaculture technology, there are two major constraints that we come across. One is the non-availability of sufficient shrimp spawners to produce seed at the desired time. Even in the event of availability of spawners, their maintenance and management becomes extremely difficult and expensive. Therefore, to ease this problem there is an urgent need to evolve a suitable technology for cryobanking of viable gametes, so that shrimp production can be made sustainable according to the need. The second constraint that is encountered by the industry is the large-scale mortality of juvenile shrimps during transportation from the hatchery site to remote rural areas where shrimp farming is being done. Sometime casualties can also be due to infection, disease or pollution. This problem could be relieved to some extent by developing a technology for storage of quality eggs, embryos and nauplii, in a viable but dormant condition. Hence, there is an urgent need to devise the technique of preservation of viable embryos and larvae under low freezing temperatures to ensure the interest and confidence of shrimp industries.

Although sperm cryopreservation has been carried out successfully in a number of commercially important aquatic species, particularly in some teleost fish[1] and also shell fish[2], the technology is still not at the stage of advanced commercial application that is seen in domestic mammals. The first successful attempt at the cryopreservation of embryos of sea urchin was reported by Asahina and Takahashi[3]. Later Zell[4] and Erdahl and Graham[5] have reported preliminary attempts to freeze the eggs of rainbow trout. Studies have been carried out to cryopreserve the embryos of Japanese medaka *Oryzias letipes*[6], rainbow trout *Oncorhynchus mykiss*[7] and zebra fish *Brachydanio rerio*[9]. In recent years a few attempts have also been made

to cryopreserve the embryos and nauplii of shrimp *Penaeus indicus*[9–11]. From a review of the literature it appears that studies on the cryopreservation of embryos and larvae of fish and shellfish are still in a rudimentary phase and much remains to be done.

The reasons given for such meagre success in this area are that in higher animals, due to the large size of the eggs and embryos, there will be interference in the penetration of the cryoprotectants and thus prevention of uniform cooling during the cryopreservation process. Sometimes the large yolk present in the eggs and embryos tends to develop crystals while freezing and damage the egg structures[12]. It has been also stated that the chromosomes in the egg are more vulnerable to damage than those in the sperms; so also the loss of membrane integrity both in the sperm and the egg is a critical damaging factor incurred during the freezing/thawing process. More recent evidence has shown that certain key enzymes in the cells get altered/broken down on freezing. In shrimps, although the size of the eggs and embryos is small, the eggs naturally absorb water soon after their release in order to get swollen and activated for fertilization. After fertilization, a strong hatching envelope (protective extra-cellular matrix) forms around the egg[13]. The presence of water and the thick protective envelope surrounding the eggs makes the freezing of viable eggs and embryos problematic[14]. Subramoniam and Newton[9] were the first to successfully preserve nauplii of *P. indicus*. They held them at – 30°C using liquid nitrogen and reported survival of 82% for nauplii frozen at – 30°C and 63% at – 40°C. They further reported that the toxicity response of the various cryoprotectants (glycerol, ethylene glycol, methanol, DMSO and formamide) to nauplii was similar. But while cryopreserving the embryos using these cryoprotectants they found that glycerol was more toxic to the morulae stage embryos. They could not achieve any success with regard to the cryopreservation of embryos. Diwan and Kandasami[14] reported some success in freezing viable embryos and larvae of shrimp *P. semisulcatus*. It is mentioned that 40–50% of the embryos preserved in concentrations of 5–20% of a mixture of DMSO and glycerol and – 10°C hatched out successfully to nauplii after 1–6 h preservation. Even the revival rate of frozen-thawed nauplii has been reported to be 50% in similar conditions. Arun and Subramoniam[15] while studying the effect of freezing rates on the survival of penaeid prawn larvae, reported that using the DMSO, ethane diol mixture at concentrations of 15 : 25 (v/v), for very high rates of freezing after 60 min of equilibration has yielded larvae of high morphological intactness and indicated the possibilities for use of this mixture in future vitrification studies. The latest developments in cryopreservation of crustacean gametes and embryos have been reviewed recently by Diwan[16].

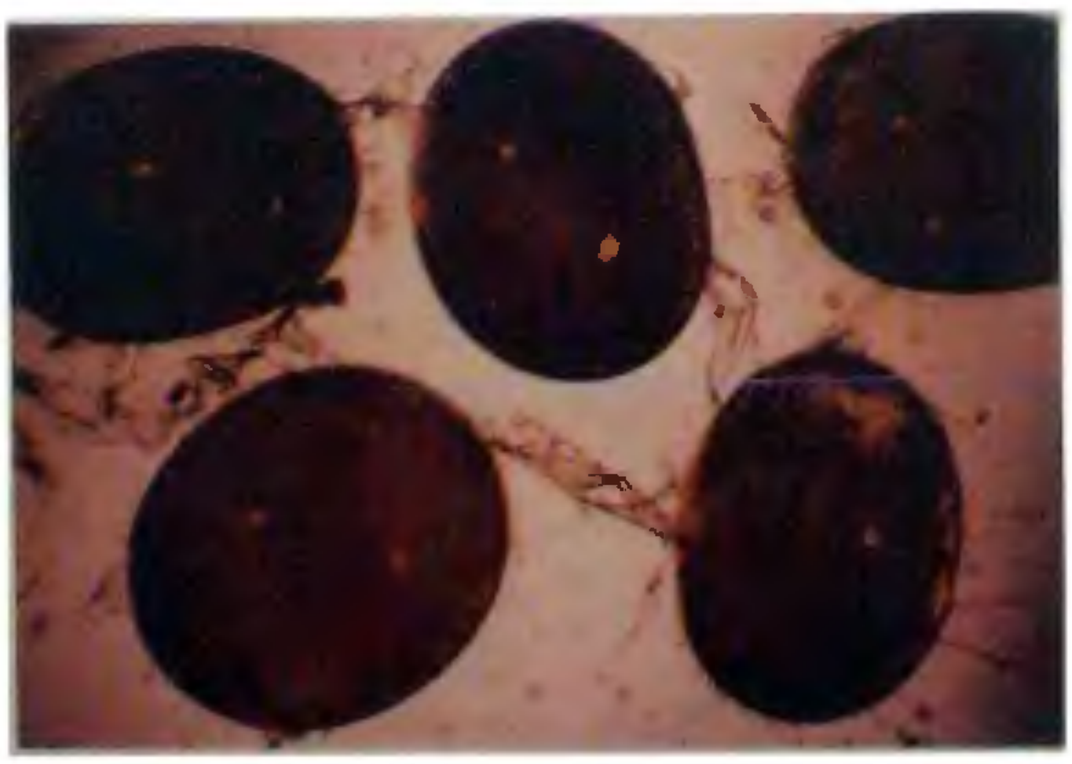

Figure 2. Developing embryos of shrimp.

Zhang *et al.*[8] while working on cryopreservation of zebra fish embryos, studied the toxicity response of different cryoprotectants such as methanol, DMSO, glycerol ethylenediol and sucrose on different stages on embryonic development. They found that DMSO and ethylenediol are more toxic to fish embryos of heart beat stage. They obtained the best embryo survival rate at – 10°C and the least at – 30°C. Ice formation within the egg was found to be the main factor affecting the survival of the embryos. When DMSO and glycerol were used independently they proved to be more toxic to the embryos and larvae of *P. semisulcatus*. Similarly, higher concentrations of cryoprotectants have been reported to be unsuitable for cryopreservation studies at – 10°C (ref. 14). The newer technique of glass embryos that has been used with some success to preserve eggs and embryos in human, cattle and sheep has to be tried for preserving shrimp embryos also. The technique involves freezing of embryos in a solution with high

glycerol and sucrose content. However, further investigation is warranted to refine the technique, once the exact nature of the damage to the embryos and nauplii by various factors during cryopreservation is known.

1. Muir, J. E. and Roberts, R. J., *Recent Advances in Aquaculture*, 1993, pp. 297–337.
2. Subramoniam, T., *Advances in Marine Biology* (eds Blaxter and Southward), 1993, vol. 29, pp. 129–214.
3. Asahina, E. and Takahashi, T., *Cryobiology*, 1978, **15**, 122–127.
4. Zell, S. R., *Ann. Biol. Anim. Biochem. Biophys.*, 1978, **18**, 1089-1099.
5. Erdahl, D. A. and Graham, E. F., Proc. of Int. Conf. of Animal Reproduction and Artificial Insemination, 1980, pp. 317–326.
6. Aril, N., Namai, K., Gomi, F. and Nakazawa, T., *Zool. Sci.*, 1987, **4**, 813–818.
7. Nilsson, E. and Cloud, J. G., *Aquat. Living Resour.*, 1993, **6**, 77–80.
8. Zhang, T., Rawson, D. M. and Morris, G. J., *Aquat. Living Resour.*, 1993, **6**, 145–153.
9. Subramoniam, T. and Newton, S. S., *Curr. Sci.*, 1993, **65**, 176–177.
10. Subramoniam, T., *Proc. Indian Nat. Sci. Acad.*, 1994, **60**, 229–236.
11. Simon, C., Dumont, P., Cuende, F. and Diter, A., *Cryobiology*, 1994, **31**, 245–253.
12. Seymour, J., *New Sci.*, 1994, **1**, 21–23.
13. Clark, W. H. and Griffin, E. J., *CRC-Hand Book of Mariculture*, 1993, **1**, 133–151.
14. Diwan, A. D. and Kandasami, D., *Aquacul. Res.*, 1997, **28**, 101–104.
15. Arun, R. and Subramoniam, T., *Cryoletters*, 1997, **18**, 359–368.
16. Diwan, A. D., in *Recent Advances in Marine Biotechnology (Aquaculture Part A)*, Science Publishers, Inc, USA, 2000, vol. 4, pp. 249–271.

A. D. DIWAN

Fish Genetics and Biotechnology Division, Central Institute of Fisheries Education (ICAR, Deemed University), Versovba, Mumbai 400 061, India
(e-mail: cife@×400nicgw.nic.in)

NEWS

Ecofriendly microbes as agents in insect pest control*

Pesticides have been the weapon against all insect pests and have contributed unprecedented effects in nature. The growing concern about their ill-effects has necessitated a change in our strategies to manage insect pests in an ecofriendly manner. Search for alternatives that would leave no negative effects on the environment prompted scientists to look for biopesticides such as microbial pesticides. India with a large agrarian society and with agriculture as the prime occupation needs to concentrate on this aspect. Papers presented by scientists from all over the country in a national symposium on microbials in insect pest management, that was organized to discuss the developments in India have stressed this aspect. Research papers were drawn on different areas such as identification and development of new microbial agents for pest management, mass production and utilization, microbial management for education, employment, economics and manpower development, etc. Some of the desirable attributes of microbial control agents and nematodes are: Rapid spread, power of search for host, persistence, safety and acceptability, control to sub-economic level, predictable control, virulence, easy production, low cost, good storage and easy application.

While admitting the success of *Bacillus thuringiensis* (*Bt*) in insect pest management this conference discussed the part played by various other microbes, viz. virus, bacteria, fungi and protozoans. A survey for the indigenous microbial pathogens resulted in the isolation of *Pandora delphacis, Beauveria bassiana, Entomophthora aulicae, E. grylli, Fusarium* sp., *Metarhizium anisopliae, M. flavoviridae, Verticillium lecanii* and isolates of NPV, from different insect pests like *Helopeltis theivora, Buzura suppressaria, Oligonychus coffeae, Nephotettix virescens, Oxya velox*, etc. (Table 1).

Most of the organisms tested for field insect pest control caused more than 50% mortality.

Results on the combinational studies revealed possible synergism of *M. anisopliae* and optimum level of synthetic insecticides against *Spodoptera litura*. *Bt* and Neem Azal were found to be more effective on *S. litura* whereas *Bt* alone was effective on *Plutella xylostella*. Additive and synergistic interactions of nematodes (*Steinernema carpocapsae*) and *Bt* showed considerable effect on root grub (*Holotrica serrata*).

Field application tests proved the superiority of wettable powder formulations where 66% mortality of rice green leafhopper (*Nephotettix virescens*) was recorded. Wettable powder, oil and freeze dried formulation showed differential

Table 1. Micro-organisms isolated from various sources

Micro-organism	Source
Verticillium lecanii *Beauveria bassiana* NPV	*Oligonychus coffeae* *Helopeltis theivora* *Buzura suppressaria*
Pandora delphacis, Beauveria bassiana, Entomophthora aulicae, Fusarium, Metarhizium flavoviridae	*Nephotettix virescens*
Bacillus thuringiensis	Soil

*Based on the National Symposium on Microbials in Insect Pest Management conducted at Entomology Research Institute, Loyola College, Chennai during 24–25 February 2000.