

developed by the Fisheries College, Panangad. K. Gopala Reddy of Nellore won the Best Freshwater Prawn Farmer Award, while Ch. Srikanth, Nellore won the Propagation Award for Scampi. The Best Young Scientist Award was won by K. R. Salin for his paper 'Live transportation of scampi without water'. The Best Scampi Exporter Award went to K. Eravikumar (Five Star Marine Exports (P) Ltd, Chennai) and the Second-Best Scampi Exporter Award to M/s Victoria Marine and Agro Exports Ltd, Chennai. Outstanding Aquaculture Scientist Award instituted by Aquaculture Foundation of India was given to C. Mohanakumaran Nair (College of Fisheries, Panangad). Best State Award for Scampi Culture Propagation was given to the state of Andhra Pradesh which now has about one lakh acres under freshwater prawn farming.

Four scientific sessions were held on the final day of the symposium. In the session on nutrition and feeds, the lead paper on *Macrobrachium* nutrition, feed and feeding was presented by Mali Boonyartpalin, Thailand. She suggested that a level of 30 to 35% of protein in diet of freshwater prawns *M. rosenbergii* is ideal. Brood stock feed of high level of 18: 2n - 6 and n - 3 HUFA (13 and 15 mg/g DW) has been found to improve fecundity, egg hatchability and overall quality of the larvae. Madhumita Mukherjee, West Bengal reported that feeding with natural food alone up to 9th day and artificial food thereafter resulted in successful production of post larvae of *M. rosenbergii*.

In the session on post-harvest technology, K. A. Devadasan, Central Institute of Fisheries Technology (CIFT), Kochi

highlighted the salient features of the post-harvest technology in giant freshwater prawn. M. K. Mukundan (CIFT, Kochi) said that chemical contaminants and antibiotic residues were threats for scampi raised by aquaculture. However, he mentioned that microbial quality of farmed giant freshwater prawns in India did not exceed tolerance limit. Cadmium, lead, mercury in ppm were within limits. It was mentioned that to reduce TPC, antibiotics were being used, which was causing problems. Mukundan said that a farming package based on sanitation and hygienic safety had to be developed for ensuring production of good quality giant freshwater prawns. In the session on economics and marketing, J. Bojan (MPEDA) reported that in India there was a spurt in the freshwater prawn farming activity in recent years resulting in production of 30,450 mt from 34,630 ha in 2002-03. He attributed this mainly to the availability of water bodies, establishment of hatcheries, production of low cost prawn feed and enthusiasm of entrepreneurs. J. V. H. Dixtulu (Fishing Chimes, Visakhapatnam) stressed the need for nation-wide promotion of giant freshwater prawn farming through survey of sites, assured aquaculture inputs and technical support for farming, processing and marketing. In the session on sustainability and environment, M. N. Kutty, who presented the lead paper, said that the annual expansion rate of freshwater prawn farming in the world during the decade ending 2001 was estimated as 29% and that between 1999 and 2001 as high as 48%. He emphasized the requirement of establishing sustainable freshwater prawn farming systems as per the guidelines formulated by FAO and other agencies in

order to prevent an unexpected collapse as in the case of shrimp farming.

Michael New, UK made remarks consolidating the points raised in the symposium in the plenary session. He was impressed with the enthusiasm shown for scampi production in India and its rapidly expanding output. Regarding hatchery technology, he suggested the need for having small seasonal hatcheries on all farms or for co-operative seasonal hatcheries that serve a number of small local farms. Breeding programmes to improve performance, and possibly the production of hybrids that exhibit the favourable characteristics of more than one species, are desirable. There is also a need to protect the natural resources in a country like India where the major cultured species are indigenous. Conservation of genetic diversity is critically important. Everybody agrees that all-male culture of *Macrobrachium* is beneficial. This can be achieved by the administration of substances derived from the androgenic gland to induce all-males. The second possibility would be the production of all-male progeny through the development of functional neo-females to be mated with normal males. Michael New said that the latter solution could lead to global dominance by a few major hatcheries that would control the supplies of superior stock, an analogous situation to that prevailing in the poultry industry globally. The former solution would better protect the small operators around the globe.

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## Animal communication\*

Studies on bio-acoustics started about 50 years ago, when Peter Marler published a research paper entitled, 'Characteristics of some animal calls' in *Nature*<sup>1</sup>. After

this, many ethologists, ecologists and behavioural biologists have been working in this field throughout the world. In India however, studies are scanty and most of them are in collaboration with foreign laboratories. Acoustical Society of America (ASA)<sup>2</sup> and International Bio-acoustics Council (IBAC)<sup>3</sup> are the two major organizations, which provide international platforms for the development of bio-acoustic studies through in-

ternational conferences and publications. The present report highlights latest developments in the field of bio-acoustics, presented in two international conferences on acoustic communication in animals, held during 2003, in North and South America, respectively.

The first International Conference on Acoustic Communication by Animals<sup>4</sup> was sponsored by ASA and the Center for Comparative and Evolutionary Biol-

\*A report on the International Conference on Acoustic Communication by Animals held during 27-30 July 2003 at University of Maryland and on the XIX International Bio-acoustics Congress held during 10-15 August 2003 in Brazil.

ogy of Hearing (C-CEBH), University of Maryland. So far, the field of animal communication has been mostly descriptive and has provided acoustical analysis of the signals for communication, phonation, and perception. However, recent investigations have examined acoustic communication in the context of evolution, ontogeny and learning, ecology, and overall behaviour. There is also greater interest in the genetic basis of communication and the role of acoustic communication within the broader, integrated context of multi-modal animal communication.

David K. Mellinger (Cooperative Institute for Marine Resources Studies, Oregon State University) demonstrated *Ishmael*, a software package for 'Automatic Recognition of Animal Species'. Nima Mesgarani and Shihab Shamma (University of Maryland) presented a 'Bird call classification' model using multiresolution spectrotemporal auditory model to estimate the populations of birds.

Recently-developed sound analysis software, RAVEN was demonstrated by Harold G. Mills (Cornell Laboratory of Ornithology). The Raven Software Development Project was initiated in 1999. It is a multiplatform sound recording and analysis programme for bioacousticians. It can display a large number of sound files simultaneously, with each file in its own window in the form of waveform, spectrogram, and spectrogram slice views.

Peter M. Narins (Department of Physiological Science and OBEE Biology, Los Angeles) presented his findings on neuroethology of seismic communication behaviour. He demonstrated the effect of seismic waves on animals and their behaviour. Obviously, studies in this direction can be useful in prediction of natural calamities.

Caitlin E. O'Connell-Rodwell (Center for Conservation Biology, Stanford University) presented his research work on the elephants' responses to seismic stimuli. Elephants produce low-frequency vocalizations in the range of 20 Hz at high sound pressure levels and are capable of detecting these vocalizations when played above a threshold of 60 dB. When an elephant vocalizes with low-frequency rumbles, a correlate of these vocalizations propagates in the ground. These seismic vocalizations have the potential to travel up to 16 km. Elephants have been

shown to detect and respond appropriately to seismically transmitted playbacks of their own low-frequency vocalizations. Elephants could vastly expand their communication repertoire by incorporating seismic signaling and could benefit from eavesdropping through the ground as an early warning system for potential danger that may exist at a distance beyond which acoustic signals can propagate.

Andrew M. Simmons (Department of Psychology and Neuroscience, Brown University) presented acoustic methods for studying frog choruses. Frog choruses are often dense, both in numbers of individuals calling and in the aggregate duty cycle of their calls. There are technical problems involved in recording and identifying specific individuals in the midst of dense choruses. Frog choruses are usually most active after dark, and the frogs can be seen only with difficulty. Many of the animals are hidden from view in vegetation around the water, and night-vision devices do not work well because they are monochromatic and frogs contrast poorly to their surroundings. The proposed method is able to estimate the direction of any given frog call from a pair of microphones and combine direction estimates from several microphone pairs to determine the location of source. It is capable of enhancing the accuracy of localization where necessary for the case of dense chorus made up of closely spaced frogs and sorting through the stream of calls to locate the same call at each microphone pair as well as classify individual frogs by their calls.

Raimund Specht (Avisoft Bioacoustics, Berlin) demonstrated compact and rugged ultrasound recording equipment for field use. Until recently, opportunities for recording animal ultrasonic vocalization in the field were limited. The commonly used time-expansion bat detectors have a low dynamic range (8 bit only) and do not support continuous recording over longer periods of time. High speed tape recorders are bulky and very expensive. High speed PCMCIA data acquisition cards installed in laptop computers suffer from fragile connectors and lack of antialiasing filters. The Avisoft Ultra Sound Gate devices are well suited for mobile hard disk recording in the field.

From India, there were only two presentations. Rohini Balakrishnan (IISc, Bangalore) presented a research paper

entitled, 'Characterization of the complex acoustic environment in a chorus of field crickets of the species *Plebeigryllus guttiventris*'. I presented a research paper entitled, 'Acoustic communication in two sympatric species of *Pycnonotus* bulbuls' which deals with characterization and significance of songs and calls in two congeneric species of bulbuls.

On the basis of papers presented in the conference, it is realized that bio-acoustic studies need to be focused on evolutionary, ecological and neurobiological investigations instead of purely descriptive studies. Discussions during the conference have opened new avenues of research especially on applications of bio-acoustics in species monitoring, conservation and their management. The most significant development is the initiation of 'Automatic Species Identification' tools. Such a technique will be useful in identification and rapid assessment of elusive species, hidden in impenetrable vegetation, or high in the canopy.

The scientific programme of the XIX International BioAcoustics Congress<sup>5</sup> was initiated with the keynote lecture of Peter Marler (Animal Communication Laboratory, University of California), on 'Innateness and the instinct to learn.' Marler explained the concepts of innateness and its importance in development of songs in birds. He discussed the relevance of avian vocalizations to answering four major questions such as ontogeny, causation, function and evolution, in which ethologists are mostly interested.

Torben Dabelsteen (University of Copenhagen, Denmark) explained the physical nature of transmission-caused sound degradation and the effects of the nature of the sound signal and of the spatial arrangement of both senders and receivers. He emphasized the possible role of environmental factors in the evolution of sound signal design and behavioural strategies. Most animals live in communication networks in which several individuals are simultaneously within signaling range of each other. This allows for complicated patterns of information flow among individuals, especially when their signals are able to pass obstacles. Acoustic signals possess this ability to some extent, but they also suffer degradation, attenuation and masking from background noise during transmission in the habitat.

David Chesmore (University of York) demonstrated the techniques and meth-

ods for automated bioacoustic signal identification. Over recent years, rapid increases in computer speed, memory and low power computing are leading to possibilities unachievable in the past. These include development of portable bioacoustic species identification systems for use in the field, long-term unattended sound identification systems and large-scale sound mapping. Current research in bioacoustic signal identification is increasing world-wide and some projects include investigations on cetaceans, birds (including nocturnal migrating birds), insects (Orthoptera, Homoptera and insect pests) and mammals (deer and bats), especially the recognition of individuals.

Thierry Aubin from Université Paris-Sud, France, discussed coding of species-specific and individual characteristics in animal sounds. That animals can recognize each other by voice has been demonstrated repeatedly by ethologists. Successful demonstration of species' vocal recognition, mainly in birds and to a less extent in mammals, prompted studies of population (dialect), neighbour-stranger, mate, parent-offspring, one-another discriminations. One of the most interesting findings of these studies is that individual recognition appears to involve vocal learning.

Michel Kreutzer (Université de Paris X-Nanterre, France) explained brain and peripheric mechanisms for vocal communication in birds and bats. For the past several decades, birds and bats have proven invaluable model systems for the study of the mechanisms involved in the

production, perception and learning of signals used for vocal communication.

Richard Ranft (National Sound Archive, London) emphasized the importance of animal sound recordings. Recordings of animal sounds have been systematically collected in many countries over the past 50 years. In recent years, technological developments have transformed the way that sounds can be sampled, stored and accessed. He reviewed internationally adopted standards for preserving sounds and offered practical advice to individual bioacousticians and archivists as to the best practices. This is particularly important today with the increasing number of samples being collected in the species-rich regions of the neotropics, and with the new challenges and opportunities offered by the digital revolution.

In this conference, I presented my research paper on the acoustic communication of red-vented bulbul. The topic of the symposium was, 'How to analyse and measure complex bird songs?' Six presentations were made during this symposium. José R. C. Piqueira (Universidade de São Paulo, Brazil) initiated the symposium, emphasizing that the complexity of the song of some bird species was not only cumbersome to describe but also a challenge to measure. Sonographic analysis permits a detailed characterization of any sound, and the most complex bird songs can be reduced to their physical parameters in a way that permits measurements and comparisons to be made. The challenge addressed in this symposium was to make objective calculations

of these complexity values. Similarities among sound units, structural organization and temporal sequencing of these sound units and the flow of the encoded information were some of the measures that would help to make comparative analysis of complex bird songs. However, such complexity was attained by very different means, rendering direct comparisons difficult to make.

Jacques Villiard (Universidade Estadual de Campinas, Brazil) concluded that emphasis should be on the development of more sophisticated technology for study of acoustic signals based on theoretical models such as 'quantum information theory' and 'quantum bit concept'. Bio-acoustic studies should be implemented in the field of environmental awareness and nature conservation. The studies should be emphasized on the neurobiological basis of phonation, production and perception of acoustic signals. Development of automatic species identification devices and bio-acoustic monitoring programme for nocturnal/secretive species can also be a major focus of future investigations.

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1. Marler, P., *Nature*, 1955, **176**, 6–8.
  2. <http://asa.aip.org>
  3. <http://www.unipv.it/webcib/ibac.html>
  4. <http://www.cultura.ufpa.br/ibac/>
  5. <http://asa.aip.org/communication.html>

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