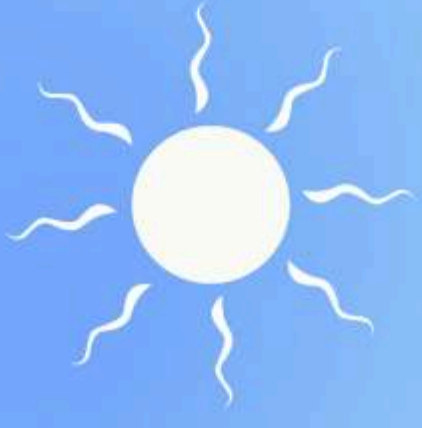
International Symposium

Marine Ecosystems
Challenges and Opportunities

9 - 12 February 2009, Kochi

Connecting ...



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MECOS 09

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Marine Biological Association of India

Cochin

Marine Biological Association of India

Connecting…, the Souvenir released on the occasion of the International Symposium MECOS, 09 -12 February 2009 at Cochin, Kerala, India, commemorating the Golden Jubilee of MBAI.

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Published by: Dr. N.G.K. Pillai The Convener, MECOS 09 on behalf of the Marine Biological Association of India, Cochin.

Citation: Vijayakumaran, K., P.U. Zacharia and V. Kripa (Eds), 2009. *Connecting*..., the MECOS Souvenir, Marine Biological Association of India, Cochin, India, xxp.

Printed at:

Modern Graphics, Malu's Complex, Kaloor, Cochin-17.
Ph: 2347266, 2342158

Exploring the Connections

When we try to pick out anything by itself,
we find it hitched to everything else in the universe.
- John Muir

Everything in this world is connected. Look at the physical world. The atoms and molecules that make the visual and invisible world are constantly changing forms transcending the connections among different entities over time and space. At the earth systems level the connectivity is more evident in the ocean-atmospheric interactions. The water and air are in constant motion and so are all those matter found in the two media, not to speak about the continental plates. We create pictures of the source, sink and cycles to facilitate our understanding of the gross phenomena. There are innumerable subtle phenomena which we seldom pay any attention to, leave alone the unknown.

Then there is the ever challenging phenomenon of life-the force that distinguishes the animate from inanimate. The connections are well defined in the basic chemical composition as well as molecular and genetic structure, not to mention about the common evolutionary path-the edifice of which is being contested. At the global environmental scenario the connections are posing challenges in the so called 'global commons' in the form of climatic variations as a consequence of various human activities.

The inspiration for MECOS is obviously the penchant desire to unravel the connections in the ocean systems. The intention is to get a wide and holistic view of the different components, intricate processes and mechanisms which make the oceans in our unique water planet. At some point, a suggestion came to make the MECOS Souvenir something different- a move away from the routine. In an attempt to defy beaten route to another 'mostly unread publication' we went ahead with gathering some information which would provide knowledge and fun to a wider section of readers from students to elderly professionals.

Of course, there are a couple of articles connecting to the roots, one remembering the inimitable late Dr. S. Jones, the founder of MBAI and the other tracing the milestones of the 50 glorious years of MBAI.

We expect our modest attempt would be liked by all the readers. None of the ideas presented here are ours and we have acknowledged all the sources of information. We have taken enough care to bring out a product within the available constraints of time and other resources. The shortcomings and omissions are unintentional. We very much welcome your feed-back. Shoot your frank and creative comments to us - that is another way to prove we are all connected.

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This is true joy in life, the being used for a purpose recognised by yourself as a mighty one; the being thoroughly worn out before you are thrown on the scrap heap; the being a force of nature instead of a feverish selfish little cod of ailments and grievances complaining that the world will not devote itself to making you happy.

- George Bernard Shaw

Love your job but never fall in love with your company because you never know when it stops loving you

- Dr. A.P.J. Abdul Kalam

Contents

1.1 Defying Limits and Bounds

Glimpses of the life and science of a visionary biologist, Dr. S. Jones
Founder President, Marine Biological Association of India

P.S.B.R. James[1] and D.B. James[2]
Fellows, Marine Biological Association of India

Santhappan Jones was born on the 27th August, 1910 at Kovalam in the Kerala State as the fifth and last child of his parents. He had his early education at Venganoor near Kovalam and at Trivandrum. He graduated from the Maharaja's College of Science, Trivandrum in 1933 and worked in the same college as honorary research scholar for an year. Later he joined the Zoology Laboratory of Madras University on a scholarship under Prof. R. Gopala Aiyer and obtained the M.Sc. degree in 1937 for the research on breeding and development of brackishwater fishes. His work on fishes attracted the attention of well known ichthyologists like Dr. Baini Prasad, Dr. Sunderlal Hora and Dr. B. Sundara Raj. He worked for a brief period at the Colombo Museum and Madras Christian College before joining the erstwhile Travancore State Service as an entomologist in 1937. He continued his entomological research work for about 10 years, contributing to the control of the coconut leaf roller, rice swarming caterpillar etc. He established the first research station on cardamom at Pampadumpara and worked on cardamom pests like thrips, hairy caterpillar and weevil and published papers in reputed journals. Dr. Nelson Annandale, the founder Director of the Zoological Survey of India, who laid the foundation for zoological research in India, was his role model.

Dr. Jones had a great passion for science from his college days. Three of the animals collected by him, two new genera of pselaphognathous diplopods and one new genus of gryllid, were described as new to science. A large number of myriapods, terrestrial isopods, fishes and several other species reported as new to science were named after him. He brought to light the existence of the true external gills in the teleostean fishes as exemplified in *Acentrogobius viridipunctatus,* and the origin of the cement gland in the cichlid fish, *Etroplus maculatus*.

Dr. Jones got married in the year 1940. Mrs. Edith Jones was a very meek, patient, loving, amiable, kind, generous and hospitable lady. She was devoted to her husband and children, two daughters and one son. She took care of the family patiently without a demur of the inevitable 'neglect' from her husband who has taken science as his 'sweet heart'. Her health deteriorated in later years of life and she passed away a few years before the demise of Dr Jones.

In 1945, the University of Travancore did an injustice to Jones by withholding the award of Ph.D. degree to him which was duly recommended by the Board of Examiners, to deprive him of a higher post subsequently. On learning the

[1]Former Director, CMFRI and President, MBAI
[2]Former Principal Scientist, CMFRI

truth, the examiners expressed their protest by returning the remuneration they received. The University covered it up by passing on the tainted money to *Vanchi Poor Fund*!

Dr. Jones was appointed Head of Estuarine Fisheries Division of the newly established Central Inland Fisheries Research Institute (CIFRI) at Barrackpore, Calcutta. At this Institute he did research on fisheries of India and the life histories of fish for which he was awarded the D.Sc. degree by the University of Madras in 1952. He held charge of the Chief Research Officer of this Institute during 1951-52. His tenure at the CIFRI saw outstanding contributions on the Indian shad, *Hilsa ilisha* and the fish and fisheries of the Chilika Lake as part of estuarine fisheries research.

In the year 1954, he was unexpectedly transferred to the Central Marine Fisheries Research Institute (CMFRI) and posted at Calicut as the Head of the Fishery Biology Division. As a result of sheer hard work, in April 1957 he was appointed Chief Research Officer (later re-designated as Director) of the Institute at Mandapam Camp at the age of 46 years. He held the post for 13 years disregarding more remunerative jobs elsewhere and with single minded dedication to foster research on marine fish and fisheries till he retired in August 1970. After retirement also he continued his scientific works as Emeritus Scientist at the University College, Trivandrum for a short time.

In the fifties, when fishery science in the country was still in its infancy, Dr. Jones strived hard to build up the nascent CMFRI as a premier organization for marine fisheries research in India. He was responsible for initiation of several new and novel programmes by which the Institute witnessed rapid development of marine fisheries research. At CMFRI, right from the beginning, he initiated research on oceanic fisheries including the tunas and billfishes, to fill the lacunae in information and data on these fishes in the seas around India. His initiative and personal interest paved the way for investigation on the fishery potential of the Laccadive Islands, leading to landmark contributions in later years under his stewardship. The tuna, live-bait and other fisheries resources were surveyed and keys for scombroid fishes were prepared. These researches brought to light the exploitable potential of the fishery resources of the Laccadive Islands.

The book *Fishes of the Laccadive Archipelago* was published in 1980 under joint authorship with Mr. M. Kumaran. It is acknowledged as the most outstanding contribution on the ichthyofauna of the Indian region for over a century since the monumental work *Fishes of India* (Francis Day, 1878). The book described 603 species of fishes in place of hardly three dozens known previously. The ecology and fishery resources of the island territories have always fascinated him. Vast collections of fishes and other organisms from these areas were made by him and his colleagues and later subjected to detailed study.

His foresight to emphasise the investigations on biodiversity of marine fauna and flora was remarkable. He assigned very diverse topics such as sponges, nudibranchs, corals, copepods, crabs, stomatopods, polychaetes and echinoderms, besides fishes, prawns, molluscs, seaweeds etc. to research scholars. The wealth of information generated on these diverse marine organisms

under his guidance will remain useful for generations to come. Most of the students who specialized on these subjects and worked under his supervision later became experts on their relevant field of specialization, recognized in and outside the country. He guided a total of 13 researchers including a few staff members for Ph.D. degrees. Lack of continued thrust in biodiversity research after his tenure had a crippling effect at a time when biodiversity is being accorded all importance.

His close association with the officials of the Indo-Norwegian Project, especially the Director of the Project, Prof. G.M. Gerhardson, paved the way for regular fisheries oceanographic investigations in the country. Dr. Jones himself participated in several cruises onboard the two research vessels, R.V. *Kalava* and R.V. *Varuna*. By using the material collected form these cruises and the collection of eggs, larvae and juveniles of scombroid fishes sent to him for examination by the Carlsberg Foundation's DANA Expedition of 1928, he could describe the young stages of scombroid fishes and deduce the distribution pattern of these fishes over a wide region in the Indian Ocean. Dr. Jones will be well remembered for his extensive and monumental contribution to the study of eggs, larvae and juveniles of several species of fish.

He evinced keen interest in the study of marine mammals, especially the dugong and the whales. Whenever he received any information on the occurrence of mammals and other unusual phenomena at sea, he lost no time to personally visit the site and undertake thorough investigation. Few of his colleagues whom he shrewdly picked up, were fortunate to work with such exciting creatures and generate valuable data and information unavailable till time.

Never underestimate the power of a few committed individuals to change the world. Indeed, it's the only thing that ever has.

- Margaret Mead

Dr. Jones was the first to anticipate the possible extermination of the dugong in the seas around India and gave the clarion call for the protection of the animal in the Indo-Sri Lankan waters. He proposed to establish a Dugong Research and Conservation Fund and a sanctuary for the animal in the Gulf of Mannar and Palk Bay. Though these proposals have not fructified during his lifetime, the present Gulf of Mannar Biosphere Reserve could be considered as manifestation of his aspirations. By his sustained interest, he not only created international thrust in dugong conservation but was instrumental in keeping a pair of dugongs alive in captivity at Mandapam Camp for 11 years, creating a world record.

His interest in science was singular and remarkable. During his visits to Lakshadweep, his curiosity was drawn on the birds of Pitti Island from where he collected some birds and their eggs for study. A number of specimens were deposited in the CMFRI Museum at Mandapam Camp. When a tidal wave struck the southeast coast in 1964, he took the opportunity to organize a study of all marine animals stranded in pools and puddles along the coast. The 24-hour round the clock field study he organized in the sixties on the Manauli Island in the Gulf of Mannar to study the influence of tides on marine animals was exciting and will be ever remembered by all participants.

His interest on endangered marine animals like the turtles, dugong and whales was such that he remained on the spot till the contemplated work was finished, whether it is the sea-side or in the laboratory. It was quite an experience for

youngsters to participate in the dissection of a dead dugong to study its anatomy and stretching its long intestine on the corridor of the laboratory to study the whole length segment by segment, for analyzing the contents, collection of parasites etc. Similar were the experiences of his scientific colleagues when stranded whales were studied on the spot and their parts transported to laboratory for further investigation.

He was a born naturalist, a keen nature observer and a down-to-earth field oriented scientist with an inquisitive eye to observe, understand and interpret nature's mechanisms and functions. When it came to work, there was no distinction of holiday or working day, day-time or night. Exhibiting an untiring capacity to work, he often spent long hours, up to midnight in the laboratory, on his own research. It is quite interesting and noteworthy to recall the 'Sunday morning field studies' at the Palk Bay near the Institute, he undertook along with several young colleagues and research scholars. Such trips also proved to be excellent training opportunity for young researchers to study marine fauna and flora. He used to silently wade through the shallow coastal waters and make astounding observations on animal associations which took many by surprise when the first few of a series were published. These papers are but a few of their kind in the country and are of special interest because of the intrinsic and strange associations between widely different animals.

Dr. Jones accorded highest priority to proper initiation and training to young researchers as he rightly believed that the future of the research institute would depend on their caliber. In the process, he would often goad his junior colleagues to attain new heights of achievement quoting old adages like: 'knowledge is power'; 'the great end of life is not knowledge but action'; 'there will be a gap between expectation and achievement'; 'your reach must be higher than your grasp' and so on. He interspersed with apt proverbs, native anecdotes and his characteristic remarks, sometimes pungent but often sprinkled with humour to bring home the point. By a series of skillfully directed questions, he would help his students and colleagues themselves to find the answer for most of their questions.

He was at times nagging, sarcastic and uncompromising with his younger colleagues but all that was in their own interest. The young researchers always benefited by his constant and unfailing guidance. He inculcated in them the scientific curiosity, keen observation, fetish for detail, sincerity, tenacity for hard work and above all a critical outlook. His interest to learn and teach youngsters in a practical way (with live, fresh and dead biological specimens) worked like a grinding mill for all aspiring scientists around him especially during the period 1958 to 1969 at Mandapam Camp. It was deliberate but veiled attempt on his part to bring about the best in them and develop their confidence and individuality. He advocated to his younger colleagues his motto 'set thy heart upon thy work and not on its reward; work not for reward and never cease to do thy work', (from *Bhagavat Gita*). True to his precepts he remained a karma yogi, never stepping into an ivory tower.

Dr. Jones was afflicted with polio in an advanced age of 53 years, rendering him wheel-chair ridden for the rest of his life. This incidence would have taken

its toll on a lesser mortal, but not Dr. Jones. If anything, it made him more tenacious, more determined. Never accepting defeat, the tempo of his activity increased tremendously, to the surprise of his contemporaries, like the Phoenix rising from its ashes. To those of his well wishers who wanted him to take 'complete rest' in view of his disability, he used to aver for their satisfaction that this would certainly be done in his grave! He challenged any unwary sympathizer of his handicap by jocularly remarking that he is 'more active above his hips' than most of his countrymen!

The most outstanding and permanent contribution of Dr. Jones to this Institute was his attempts and perseverance to shift the headquarters of CMFRI from Mandapam to another location like Madras or Tuticorin amidst stiff opposition from several quarters as he felt the original headquarters was unsuitable for a growing and premier national research Institute. However, the Estimates Committee of the Parliament and the ICAR ultimately took a positive decision in favour of Cochin, thus paving the way for the realization of his life's ambition at the fag end of his service. The indomitable courage and determination with which he successfully thwarted certain attempts to dismember the Institute can hardly find a parallel. This he did single-handedly while confined to the wheel chair, in utter disregard to his own chances of further continuing as its Director. He was an able administrator whose dedicated service, dynamic leadership and outstanding contributions will be always remembered.

Exhibiting extraordinary courage and grit he remained in office for about six years in the wheel chair and faced several adversities. He traveled far and wide in this condition. Since retirement from service, Dr. Jones has served on the Boards of several scientific, technical and social organizations, keeping himself aloof from all non-charitable and non-intellectual pursuits. As Chairman of the 'Nature Conservation and Aquatic Sciences Service' which he started in 1978, Dr. Jones offered his services relating to those matters to all those who approached him gratis. He took keen interest to inspect parts of the Silent Valley of Kerala during the period 1980-81, to see how best this extant, virgin, evergreen forest can be saved from undue destruction. Dr. M.G.K. Menon, former Scientific Advisor to the Govt. of India nominated Dr. Jones to examine the report prepared by Zoological Survey of India on the Silent Valley Project which was opposed by several environmentalists who opined large portions of the area would go underwater if the Project was implemented. He expressed his strong dissatisfaction of the report and made some scathing remarks on it. He had great passion for the study of world geography, history, mythology and folklore which added colour to his occasional loquacity.

Dr. Jones traveled widely both in India and many parts of the world both during his service and after retirement. On the very day he retired, he had to proceed to Hawaii to attend an international workshop on tuna larvae at the invitation of the U.S. Government. The other conferences he attended later include: FAO Conference on marine mammals at La Jolla, California (1974); FAO international meeting on mammals in the seas at Bergen, Norway (1976); Workshop/Seminar on dugong at Townsville, Queensland, Australia; Symposium on dugong held at Tokyo University, Japan (1979); Workshop/Seminar on whales of the Indian Ocean sanctuary held at Zeist, Netherlands (1981); Symposium on marine

mammals of the Indian Ocean under the auspices of the National Aquatic Resources Agency, Sri Lanka, Colombo, 1983 as its Convener; 'Whales Alive' Conference, Boston, U.S.A. 1983 at the invitation of the International Whaling Commission; and the international symposium on marine sciences in the Indian Ocean region held at Mombassa, Kenya (1995).

The greatest of all his professional contributions and an important milestone in the history of marine sciences in India was the founding of the Marine Biological Association of India (MBAI) in 1958 at Mandapam Camp. He successfully brought out its official organ, *Journal of the Marine Biological Association of India* (JMBAI) in 1959 itself, which helped knowledge pervade across the oceans and frontiers of several countries of the world. With the support of several colleagues, he tirelessly built up the MBAI over the years as an important professional body in marine sciences.

He conceived and organized several international symposia on subjects of interest such as the *Scombroid fishes* (1962), *Crustacean*s (1965), *Mollusca* (1967), *Corals and Coral Reefs* (1969) and *the Indian Ocean and Adjacent Seas* (1971), the last one held after his retirement. They were well attended and the proceedings of all the symposia were published and well received all over the world. All these created history in the country providing firm foundations for further research development of marine sciences. As the Director of the Institute, he organized the *Symposium on the Living Resources of the seas around India* in 1968, documenting all knowledge on marine living resources generated by the Institute.

The JMBAI and the Symposia greatly helped to disseminate research results and provide a platform for interaction among scientists, experts, planners and administrators for evolving strategies for future development. The journal and the proceedings of the symposia remain valuable and indispensable reference for marine scientist throughout the world. The symposium on corals and coral reefs was internationally accepted as the first and a forerunner of subsequent symposia on the subject elsewhere. The *Bibliography of the Indian Ocean* compiled and edited by Dr. Jones after his retirement, containing publications relating to the Indian Ocean prior to 1970, is the only one of its kind serving as a valuable reference. Even after his retirement, he kept sustained interest in the progress of the MBAI and attended the meetings despite personal inconvenience.

The MBAI also published a few monographs on different groups of marine organisms. Monographic work is difficult to accomplish without availability of extensive literature and publications, original descriptions, translation services (most of the original works are in other languages) and type specimens for comparison. However, he tried his best to furnish the Institute Library with several publications and purchased monographs on several groups like pogonophores, pycnogonids etc. which could be useful to research scholars. Though the idea of monographs was unique, some of these publications on certain fishes, *Ceratium*, *Dinophyceae* etc. did not click well in the market.

By a series of contributions on the mussel fishery in India and its potential and by holding the *Symposium on Mollusca*, he paved the way for the initiation of molluscan culture practices in the country. If he were alive today, he would have been happy to see the progress of mussel culture along the west coast of India which produce annually more than 15,000 tonnes, sustaining livelihoods of coastal people. This is yet another instance of forethought and vision of Dr. Jones.

Dr. Jones published 176 papers on fish and fisheries of India, besides aquatic mammals and other fauna. In recognition of his rich and varied contributions to science, Dr. Jones was elected as Fellow of the Indian Academy of Sciences, the Zoological Society of India, the National Geographic Society, etc.

For a scientific association to survive and progress for 50 years, maintaining timely publication of its journal of high international standards is no small achievement. The credit duly goes to its visionary founder who instilled the right spirits and all those who tirelessly worked and contributed to the development of the Association to its present stature. It was the ardent wish of the founder that the Association should be self-sufficient, free from any strings and shackles, financial and otherwise, to function smoothly to achieve its cherished goals of serving science and the scientific community.

It is gratifying to note that the MBAI lived up to his expectations in a great measure, self sustaining up to 1968. In subsequent years MBAI availed ICAR grants for publication of JMBAI, like any other scientific journal. All members of this internationally reputed Scientific Association should feel proud for the landmark contributions it made in the past and fervently work for its further growth and continued service to the cause of marine sciences.

On completion of 50 glorious years (1958-2008) MBAI is organizing the *International Symposium on Marine Ecosystems* (MECOS 09) from 9th to 12th February at Cochin, India. It will be a great landmark and tribute to the illustrious founder, Dr. Jones, whose forethought and zeal for the development of marine sciences in India placed this country prominently on the world map of marine sciences.

Dr. Jones will be well remembered for his humanitarian and philanthropic work, especially with polio affected children. He devoted much of his time and energy for the construction of the 'Home for the handicapped' at Trivandrum, the largest of its kind in Asia, and offered shelter to numerous polio stricken children from all over south India. The Bishop of Trivandrum gave him good support and he received a huge grant from German Mission and even sent his wife to Vienna to collect funds. The Emperor of Japan, Akihito, who was a marine biologist and a friend of Dr. Jones, donated a large number of computers for the Home and the Catholic Bishop a large number of wheel chairs. Several of his CMFRI colleagues also made donations.

Till his demise, he directed most of his intellectual faculties and energy for providing succor to these needy children. He used to personally guide and supervise all the activities of the Home from morning till evening on each day. The institution made tremendous strides in its development in various facets and in a short span of over a decade of its existence; it has become the foremost of its kind in India.

The Polio Home has an honorary director, a matron, a physiotherapist, a cook, office staff and a few supporting staff. It was designed with ramps, side supports, low sinks and low toilets etc for the convenience of the polio affected and physically challenged children. The Home also has a reading room, a physiotherapy hall and a guest room, which is made available free to the needy accepting only voluntary donation. Children are sent to schools, where some of them excelled. A souvenir was published on completion of a decade of service. On the passing away of Dr. Jones, the management of the Home was taken over by the Church of South India. His yeoman service to the disabled and physically challenged children, is most praiseworthy and will ever be remembered as an epithet of his humane and philanthropic nature. In recognition of his efforts, Dr. Jones was honored by the former President of India, Shri Zail Singh in New Delhi.

Dr. Jones was a multifaceted personality imbibing sterling qualities. His tenacity, sense of purpose, dynamism, dedication and tireless pursuit for research, indomitable courage, indefatigable energy and drive, prodigious memory, integrity, generosity and leadership made him indeed a remarkable man. He was extremely simple, ordinarily dressed with no pomp and euphoria. By sheer will power he nearly overcame his boyhood stammering. Baring his polio affliction, Dr. Jones enjoyed good health. His zeal to do something original continued to sustains his mental vigor and general health till his death. Blazing new trails and thriving to be second to none are part of his dominating personality. He carried out the programme of work undeterred and unmindful of either rewards or consequences. Dr. Jones stands out among his fellow fishery scientists by virtue of his invaluable contributions on fish and fisheries of the country and establishing the MBAI.

A glorious era in the history of Indian marine sciences came to an end on 9.01.1997 when Dr. Jones breathed his last at Trivandrum. He strode like a colossus in different walks of life and left indelible footprints in the field of marine science. He will be remembered for generations to come and will remain a flaming inspiration for several generation of marine scientists in India and abroad.

> When we no longer look at an organic being as a savage looks at a ship, as something wholly beyond his comprehension; when we regard every production of nature as one which has had a long history; when we contemplate every complex structure and instinct as the summing up of many contrivances, each useful to the possessor, in the same way as any great mechanical invention is summing up of the labour, the experience, the reason, and even the blunders of numerous workmen; when we thus view each organic being, how far more interesting – I speak from experience-does the study of natural history become!
>
> - Charles Darwin,
>
> Origin of Species

1.2 The Marine Biological Association of India Reminisces and Reflections

E.G.Silas

Former President, The Marine Biological Association of India

The saga of the Marine Biological Association of India which started in December 1958, and the biotic environment in which it was nurtured to attain its present standing, nationally and internationally, completing half a century would not have happened, but for the untiring efforts of its founding father, late Dr. Santhappan Jones - a visionary, an administrator, a man of wit and compassion, and a futurologist. Who else could think of starting a scientific association in the then remote Central Marine Fisheries Research Station (CMFRS), Mandapam Camp? A person of grit, courage and confidence, he could see the potential and the untapped resources available for organizing such a venture. The erstwhile Madras Fisheries Department had already established a Marine Biological Station on Krusadi Island making it a Mecca for zoologists, botanists and marine biologists, professors and students from colleges and universities in India to visit and study marine life which abounds in the Gulf of Mannar and Palk Bay, especially skirting Rameswaram, Krusadi and other islands. Rich in animal and plant diversity, it was and is a paradise for those who wish to study marine life. An important consideration would have been to motivate and tap the talents of the relatively young multidisciplinary scientific pool at the CMFRS. This was also at a time when there was not a single dedicated scientific journal in India to cater to marine sciences.

When I joined CMFRS at Mandapam Camp as an Honorary Researcher in June 1959, I was targeted by a very proactive group of scientists in the campus extolling the virtues of the newly founded MBAI and over night I enrolled as a Life Member paying Rs.150. Individual Membership was only Rs.10 per annum with an entrance fee of Rs.5 and Institutional Subscription only Rs.15 per annum. Foreign Life Membership was Rs.200, and individual Rs.12.50 and Institutional Rs. 20 per annum. Incredible! Over and above this, the Journal priced at Rs.35 was issued free to Members. The Rupee had its value then, the exchange rate for an US $ being about Rs. 6. Despite such tempting offer, it was not an easy task to build up the membership. Dr. Jones would joke that professors and students spend more than Rs.10 a week in smoking, but would be reluctant to become a member.

It takes time for any Association of this nature to take off, but the MBAI within a few months of its inception was showing an explosive growth in its activities. The prompt publication of the first volume of the Journal with good scientific content and embodying varied activities gave a great flip to the nascent Association. The greatest asset was the dedicated and committed office bearers Dr. Raghu Prasad, Dr. Prasana Varma, Dr. P.R.S. Tampi, Dr. P.V. Ramachandran Nair, Dr. P.S.B.R. James, Dr. K.M. Gopal, Dr. D. Sudarsana Reddy and others.

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The selection of the Logo of the Association, namely "The Investigator", was most appropriate. This Royal Indian Marine Research Ship of the late 18th and early 19th centuries was on par with "The Challenger" and had the distinction of having Surgeon Naturalists A. Alcock, Wood-Mason, Lloyd, Seymour Sewell and others exploring the pelagic, mesopelagic and abyssal depths of the Indian Seas including the Andaman Sea bringing to light many organisms new to science indicating the richness of the biodiversity of tropical seas. Despite changes in the cover page, I am glad that the Logo is being retained till today.

Turning the pages of Volume I of the Journal would reveal the scope and objectives of the Association as well as the range of activities the Association was involved with. A "Marine Biological Service" to cater to the needs of the educational Institutions in conducting studies on the marine biota was a laudable activity. The Members of the Association also contributed greatly towards building up an excellent Marine Museum at the Mandapam Campus.

A stimulating recreational activity at the time was the Association's "Snorkel League" also associated with well known under water experts in scuba diving and snorkeling. Rodney Jonkloss from Colombo, Sri Lanka was an Honorary Adviser, with K.M.Gopal as Convener. The Italian Scuba Diver, Dr. F.B. Salvadori who trained some of our young scientists such as Mr. Nagappan Nayar, Mr. S. Mahadevan, Mr. Issac Rajendaran (from Madras Fisheries Department) and others were associated with the League and donated sets of equipments for use. These are nostalgic recollections of precious moments which have faded away in the history of the Association.

Between 1962 and 1985, the Association held seven International Symposia. I had the pleasure of convening four of them, namely (1) The Symposium on Scombroid Fishes; (2) The Symposium on Indian Ocean, Its Origin, Science and Resources; (3) The Symposium on Endangered Marine Animals and Marine Parks' and (4) The Symposium on Coastal Aquaculture; besides involving actively with the others on Crustacea; Mollusca and Corals and Coral Reefs. The last said, held in 1969, was the First International Symposium on Corals and Coral Reefs held globally, the second and third being held by International Organizations at Brisbane and Florida in 1973 and 1977 respectively. In addition, there was the Journal, Special Publications and Memoirs prepared by Members of the Association. All these helped to enhance the status and reputation of the Marine Biological Association of India.

Always things have not been hunkey dory. As I reminisce, I must say that there were moments of concern about the very existence of the Association. There were impediments of various nature which the Association was able to overcome from time to time. I recollect an interesting event when two days prior to the inauguration of the Symposium on Scombroid Fishes on 12 January, 1962, the Director, CMFRI who was also the President of MBAI received a missive from the Fisheries Development Advisor, Ministry of Agriculture, Delhi instructing him that no work of the Institute on Scombroid Fishes should be discussed in a public forum. The message was passed on to me being the Convener, and the printed Abstracts had been delivered from Madurai the same day. The only option open to me was to despatch a person to Ramand to get a rubber stamp made, which was received by late evening, and with some colleagues we had to stamp 21 Abstracts in each Book as "WITHDRAWN"!! Looking back, I feel in a way this improved the Content of the Proceedings which was published in four volumes containing papers from eminent workers on Scombroid fishes

from India and all parts of the world and was in such demand that it went out of print soon.

There were many such experiences the Association has gone through and emerged to grow from strength to strength. Another interesting incident was in early 1975, the Assistant Director General (ADG), Fisheries, ICAR rang me up from Delhi to find out whether I would be in Cochin on a particular date as he had to meet me on an urgent matter. I was not on tour and met the ADG at the appointed time at the office. In his usual style, the ADG opened the topic in the presence of the local officer-in-charge that he had an unpleasant duty to perform. He had been sent by the Secretary, ICAR with a charge sheet to look into an allegation by the Ad-hoc Director of the Institute, of indiscipline and misuse of office staff and equipment on my part. I was rather taken aback, as I had gone to meet him thinking that he had to say something about the programmes of *R.V. Varuna* which I was handling and he was also interested in. The sum and substance was that I was using an office assistant to do secretarial work for the MBAI Symposium on Indian Ocean and Adjacent Seas - Its Origin, Science and Resources. There were about 330 papers to be edited and published, some of them in French and German. It was a daunting task, and I had taken the help of an office staff and he in turn used the office typewriter after getting formal permission from his superiors to also receive an honorarium from the Association. The ADG being an out and out gentleman with the highest integrity gave me and the office assistant a patient hearing and with his usual smile closed the file and left for Delhi. To make matters short, my appointment order as Director of CMFRI was delayed by about five months!!

There was a strong suggestion by some that the papers of the above mentioned Symposium should be returned to the authors. We had committed to publish them, and the only alternative I could find was to print them in the Associations Journal in Volumes 14 to 18. I am ever grateful to Mr. P.T. Meenakshisundaram who was at the Madras Research Centre of CMFRI, an ardent supporter of the Association. His help of getting the proofs from the Diocesan Press, mailing them and also helping me at a time of crisis, are matters which I can never forget.

In the early seventies there was also a crunch of the funds of the Association due to committed payments for some Special Publications. The situation was such that doubts arose whether the Association would survive. In fact, one of the Founding Life Members of the Association sent a resignation letter stating that he would not be responsible for any liabilities!! Well, that era is over and the Association has pulled through and is in better times. I mention these because scientific institutions and society some times loose sight of positive thinking and action, initiative and creativity. Such things should never happen.

As President of the Association for ten years from 1975, my colleagues and I have seen to the well being and growth of the Association, I am very happy that my successors, Dr. P.S.B.R.James, Dr. P.V. Rao, Dr. M. Devaraj, Dr. V.N.Pillai, Dr. M.J. Modayil, Dr. N.G.K. Pillai and now, Dr. G. Syda Rao are steering the Association to higher realms. The holding of MECOS 09 at this time taking into account our awareness of global problems of concern in marine ecosystems is timely. I wish the Association all success to be a fruitful and harmonious instrument for the development of ocean sciences, the associated biota and their judicious use.

2.1 Deep Ecology

The publication of Rachel Carson's book *Silent Spring* in 1963 was a turning point in the environmental literature. Carson and several writers and activists like Henry David Thoreau, John Muir, Aldo Leopold and Gifford Pinchot were collectively responsible for the shift in environmental thinking which resulted in modern environmental movements in different avatars. A decade later in 1973, Norwegian philosopher and mountaineer Arne Naess introduced the phrase "deep ecology" to environmental literature laying foundation to a new branch of ecological philosophy (ecosophy) that considers humankind an integral part of its environment.

Deep ecology places greater value on non-human species, ecosystems and processes in nature than conventional environmental and green movements. It has laid the foundation of a new environmental ethics- the biospheric egalitarianism- the claim that, like humanity, the living environment as a whole has the same right to live and flourish. The "deep" movement involves in persistently asking deeper questions concerning "why" and "how" right down to fundamental causes in the context of environmental conflicts and impacts of human life as one part of the ecosphere. Going beyond the narrow view of ecology as a branch of biological science, it aims to avoid merely utilitarian environmentalism, which is concerned with resource and environment management for human purposes.

The distinguishing and original characteristics of the deep ecology movement were its recognition of the inherent value of all living beings and the use of this view in shaping environmental policies. Those who work for social changes based on this recognition are motivated by love of nature as well as for humans. They recognize that adopting the approach of "business as usual", without changes in basic values and practices, we will destroy the diversity and beauty of the world, and its ability to support diverse human cultures.

The modern short-term, shallow approaches stop before the ultimate level of fundamental change, often promoting technological fixes (e.g. recycling, increased automotive efficiency, export-driven monocultural organic agriculture) based on the same consumption-oriented values and methods of the industrial economy. The long-range deep approach involves redesigning our systems based on values and methods that truly preserve the ecological and cultural diversity of natural systems.

Accepting the principles of deep ecology entails a commitment to respecting the intrinsic values of richness and diversity. This is in contrast to the industrial culture, whose development models construe the Earth only as raw material to be used to satisfy consumption and production—to meet not only vital needs but inflated desires whose satisfaction requires more and more consumption. While accepting industrial culture as the only acceptable model for development, its monocultures destroy cultural and biological diversity in the name of human convenience and profit.

Gandhian nonviolence is a tenet of deep ecology activism in word and deed. A common prayer we Indians utter daily: *Lokasamasta Sukinobavantu*, connotes the core principle of deep ecology.

Adapted from: http://en.wikipedia.org/wiki/Deep_Ecology and http://www.deepecology.org/movement.htm (accesed on 09-01-2009)

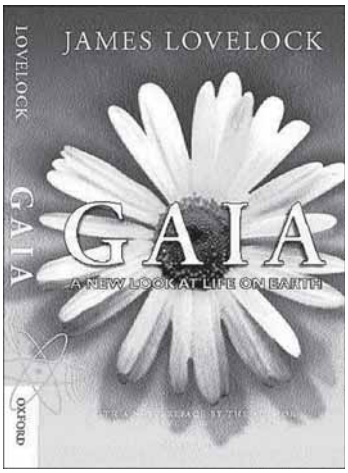
2.2 Gaia Hypothesis

Gaia hypothesis considers the Earth as a living being-Gaia- a bigger, more ancient, and more complex than anything from our wildest dreams. About one billion years after its formation, our planet was occupied by a meta-life form which began an ongoing process of transforming this planet into its own substance. All the life forms of the planet are part of Gaia. In a way analogous to the myriad different cell colonies which make up our organs and bodies, the life forms of earth in their diversity co-evolve and contribute interactively to produce and sustain the optimal conditions for the growth and prosperity not of themselves, but of the larger whole, Gaia. The very makeup of the atmosphere, seas, and terrestrial crust is the result of radical interventions carried out by Gaia through the evolving diversity of living creatures.

Viewing the Earth from space, a witness would feel that the planet is alive. The atmosphere would give a clue to support such a thought. The atmospheric compositions of our sister planets, Venus and Mars, are: 95-96% carbon dioxide, 3-4% nitrogen, with traces of oxygen, argon and methane. The earth's atmosphere at present is 79% nitrogen, 21% oxygen with traces of carbon dioxide, methane and argon. The difference is Gaia, which transforms the outer layer of the planet into environments suitable to its further growth. For example, bacteria and photosynthetic algae began some 2.8 billion years ago extracting the carbon dioxide and releasing oxygen into the atmosphere, setting the stage for larger and more energetic creatures powered by combustion, including, ultimately, human species.

It is interesting to know how James Lovelock came up with Gaia hypothesis. In the 1960's, during the space race which followed the launching of Sputnik, he was asked by the Jet Propulsion Laboratory and NASA to help design experiments to detect life on Mars. The Viking Lander gathered and tested some Martian soil for life with no results. Lovelock had predicted as much, by analyzing the atmosphere of Mars that it is in a '*dead equilibrium'*. By contrast, the atmosphere of Earth is in a '*far from equilibrium*' state- meaning that there was some other complex process going on, which maintained such an unlikely balance.

Lovelock's approach was not popular at NASA because NASA needed a good reason to land on Mars, and the best was to look for life. Viking found nothing on Mars, but Lovelock had seen the Earth from the perspective of an ET looking for evidence of life. And he began thinking that what he was seeing was not so much a planet adorned with diverse life forms, but a planet transfigured and transformed by a self-evolving and self-regulating living system. By the nature of its activity it seemed to qualify as a living being. He named that being Gaia, after the Greek goddess which drew the living world forth from Chaos.



"The name of the living planet, Gaia, is not a synonym for the biosphere-that part of the Earth where living things are seen normally to exist. Still less is Gaia the same as the biota, which is simply the collection of all individual living organisms. The biota and the biosphere taken together form a part but not all of Gaia. Just as the shell is part of the snail, so the rocks, the air, and the oceans are part of Gaia. Gaia, as we shall see, has continuity with the past back to the origins of life, and in the future as long as life persists.

Lovelock points out that Gaia, being ancient and resourceful enough to have carried out the successive changes of the planet, in spite of asteroid collisions and other setbacks, is herself probably not endangered by the relatively momentary depredations of the human species, as it befouls and cripples the biodynamics of its environment. Rather, the danger is to the human race, not only from our own actions, but also by Gaia's reaction to them. He adds the caveat however, that the passage of a bullet is also momentary, but the damage nonetheless lethal, and that we are not in a position yet to say whether or not some sudden, human caused imbalance, at a critical juncture, might be catastrophic to Gaia.

Lovelock first exposed his idea in his 1979 book, *Gaia, a New Look at Life on Earth*. The science behind the hypothesis was still sketchy, and it provoked a storm of criticism. It also provoked a lot of research, and the resulting body of information has encouraged Lovelock to publish his second book, *The Ages of Gaia*, a more confident and complete exposition of the Gaia hypothesis. The idea of Gaia may facilitate the task of converting destructive human activities to constructive and cooperative behavior. It is an idea which deeply startles us, and in the process, may help us as a species to make the necessary jump to planetary awareness.

Does the hypothesis draw some similarity to the Indian (and perhaps several others too) mythology of describing the Earth as *Bhoomidevi,* susceptible to the various ill-doings of demons (human beings?) from time to time, and seeking divine intervention for stability?

Adapted from: The review of James Lovelock's *The Ages of Gaia* (published in 1989) by Stephen Miller, 1989. (accessed at: http://erg.ucd.ie/arupa/references/gaia.html on 02-01-2009)

How Big is Your Ecological Footprint

2.3 The Earth is a small planet with limited resources. The earth systems sustain by the cyclic processes of material and energy flows which in turn define the assimilative capacity of the system. A natural ecosystem has the capacity to function within the limitations imposed by the earth systems. Whenever limits are crossed by some unusual events, there are mechanisms by which the system is brought back to the original equilibrium. The story is different when human beings enter the picture. In the process of creating 'unlimited wealth' human society engages in excessive exploitation of resources beyond the capacity of the earth to replenish them. More over, human society produces pollutants beyond the assimilative capacity of the earth systems.

The ecological footprint is a broad measure of resource use and a complex sustainability indicator highlighting consumption in relation to environmental limits.

It is a measure of human demand on the Earth's ecosystems– the Earth's ecological capacity to regenerate. Although the focus of current policy and science is on accounting for greenhouse gases, constraints on other resources such as food are also becoming increasingly apparent. The ecological footprint uses units of bioproductive area (global hectares of land and sea) to assess the nature and scale of the environmental impact of a country, region, community, organisation, product or service or even an individual. It represents the amount of biologically productive area needed to regenerate the resources consumed and to absorb corresponding waste generated by a given entity.

Using this assessment, it is possible to estimate how much of the Earth (or how many planet Earths) it would take to support humanity if everybody lived a given lifestyle. While the term *ecological footprint* is widely used, methods of measurement vary. However, calculation standards are now emerging to make results more comparable and consistent.

The use of bioproductive area as a composite measure makes it a powerful and resonant means of measuring and communicating environmental impact and sustainability. In this sense it is comparable to many economic indicators such as the Retail Prices Index (RPI), Gross Value Added (GVA) and Gross Domestic Product (GDP). The ecological footprint can also be used in cost-benefit analyses, to assess corporate risk and to model alternative business strategies and scenarios using existing, official statistics on consumption and waste generation.

Ten billion (people) with everyone following an American diet… would require 9 billion tonnes of grain, the harvest of more than four planets at Earth's current output levels… achieving even modest gains is becoming difficult

-State of the world, 1999.

According to a footprint analysis, humanity is exceeding its ecological limits by about 39 percent. Try to compare the footprint of an average US citizen and with that of an African citizen! How equitably we share our *global commons*?

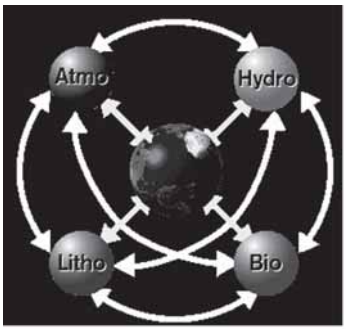
Doesn't the idea of footprint resonate in the famous words of Mahatma Gandhi "The earth has sufficient resources to meet everyone's need but not everyone's greed".

Adapted from: http://en.wikipedia.org/wiki/Ecological_footprint
http://www.rprogress.org/ecological_footprint about_ecological_footprint.htm
http://www.bestfootforward.com/ecological_footprint (accessed 09-01-2009)

2.4 Why the Systems Matter?

Most of us are so accustomed to the word "system" used in our everyday dialog, we rarely think about what it means. A formal definition might note that a system is a group of parts that come together, interacting and interdependent, to form a more complex whole unit. A simpler and more familiar way to say this might be that the whole unit is greater than the sum of the parts. Looking into the broad implications of this idea, and how it relates to 'systems biology', it is worthwhile look at a very simple system. Consider the following three items:

1. a small metal cup, about the size of a walnut.
2. a glass bowl, in the shape of a small balloon.
3. a length of tungsten wire, very brittle alas, pinched up into a small coil.



On their own, each of these parts is rather useless. But what happens if we put them all together to make an electric bulb. Suddenly we have three relatively useless parts working together as a system- as a light bulb. It has this amazing ability to give us light-something that would be totally unexpected from just looking at each of the three oddball parts in our original list.

This system called light bulb can itself become a part within larger systems such as a floodlit stadium, a runway, a pavement etc. The point is that individual parts, seemingly mundane on their own, can combine in unexpected ways into a *system*. And *the interaction of the parts in this system* creates important properties or functions we would not expect from looking at the individual parts, each on their own.

These properties and functions that arise from the interacting parts in a system are *emergent properties*. The concept of emergent properties is central to the study of systems. Any function performed by a system that is not the result of a single part in the system, but rather is the result of interacting parts in the system, is an emergent property. The light bulb's ability to generate light cannot be attributed to any of the three parts in the system on their own. Rather, it is the result of *the combination* of the metal cup sealing the glass bulb and passing current to the wire coil, the glass bulb maintaining a vacuum and still allowing light to radiate out, and the wire coil glowing hot enough to give off light without melting itself or the glass balloon. The light bulb's ability to give off light emerges only as a result of the interactions of all the parts.

Systems that have emergent properties are said to be *irreducible*. They cannot be reduced to their individual parts or studied one part at a time, with the expectation of understanding the emergent properties of the system. Remember, emergent properties are the result of the interactions between system elements, not the result of parts on their own. A system is said to be *complex* if its emergent properties are unpredictable.

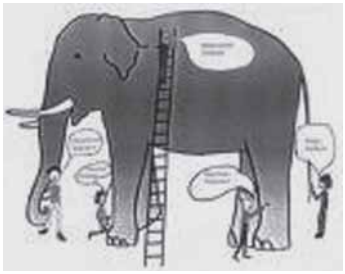
Life itself is another example of a complex system since life cannot be predicted simply by analyzing the chemicals and organic compounds that comprise the tissues and organs that make the body. Understanding life in all its complexity is possible by studying the interaction of all the parts that comprise each organism.

With our growing knowledge of the genetic constitution of life forms and the way genes control the form and functions, modern biology focuses on how genes and proteins produced from genes interact. The complexity of human genetic makeup (approximately 25,000 genes) plus the myriad of proteins produced from these genes, give rise to the extraordinary functions of human body (remember, emergent properties) and the corresponding complexity of a human being as systems.

Adapted from: http://www.systemsbiology.org/Intro_to_ISB_and_Systems_Biology/Why_Systems_Matter (accessed on 09-01-2009)

2.5 Holistic Science

The classical orthodox science is often termed as *reductionist science* or the *reductionist paradigm*. This term points at the tendency of classical science to break systems down into manageable parts for study. The holistic premise is that there is a possible qualitative difference between an entire system and its parts.



Investigating an elephant

Holism in science is an approach to research that emphasizes the study of complex systems. Two central aspects to holistic approach are:

1. the method of science is sometimes called "whole to parts," which focuses on observation of the specimen within its ecosystem first before breaking down to study any part of the specimen.
2. the idea that the scientist is not a passive observer of an external universe; that there is no 'objective truth,' but that the individual is in a reciprocal, participatory relationship with nature, and that the observer's contribution to the process is valuable.

The term *holistic science* has been used as a category encompassing a number of scientific research fields. The term may not have a precise definition. Fields of scientific research considered potentially holistic do however have certain things in common.

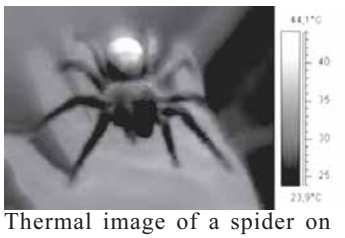
- First, they are multidisciplinary.
- Second, they are concerned with the behavior of complex systems.
- Third, they recognize feedback within systems as a crucial element for understanding their behavior.

As applied to science, holists may generally assert that this difference can warrant the kind of rigorous scrutiny typical of scientific inquiry. The distinction of approach then lies not so much in the subjects chosen for study, but in the methods and assumptions used to study them. For example, in the field of quantum physics, David Bohm pointed out that there is no scientific evidence to support the dominant view that the universe consists of a huge, finite number of minute particles, and offered in its stead a view of *undivided wholeness*.

Though considered by some as an alternative, holistic methods are not generally at odds with the classical scientific method. Where holistic scientists come from a standard science background, holistic work in science tends to be, to varying degrees, a marriage of the two approaches. For example gestalt psychology grew out of early experimental psychology. When the terms are used constructively in the science context, holism and reductionism refer not only to how empirical evidence is interpreted, but also to the methods used to produce such evidence.

Adapted from: http://en.wikipedia.org/wiki/Holism_in_science (accessed 09-01-2009)

2.6 Ecological Homeostasis


Thermal image of a spider on human hand

Homeostasis (from Greek: *hómos*, "equal"; and *istçmi*, "to stand" lit. "to stand equally"; coined by Walter Bradford Cannon) is the property of either an open or closed system, especially a living organism, that regulates its internal environment so as to maintain a stable, constant condition.

With regard to any given life system parameter, an organism may be a *conformer* or a *regulator*. Regulators try to maintain the parameter at a constant level over possibly wide ambient environmental variations. On the other hand, conformers allow the environment to determine the parameter. For instance, endothermic animals (mammals and birds) maintain a constant body temperature, while exothermic animals (reptiles and fishes) change their body temperature with the environment. Ecological homeostasis is found in a climax community of maximum permitted biodiversity, given the prevailing ecological conditions.

An example of a disturbed ecosystems is the volcanic island of Krakatoa. Due to a major eruption in 1883, the established stable homeostasis of the climax ecosystem was destroyed and all life eliminated from the island. In the years after the eruption, Krakatoa went through a sequence of ecological changes in which successive groups of new plant or animal species followed one another, leading to increasing biodiversity and eventually culminating in a re-established climax community. There were eight hundred different recorded species in 1983, one hundred years after the eruption that cleared all life off the island. Evidence confirms that this number has been homeostatic for some time, with the introduction of new species rapidly leading to elimination of old ones.

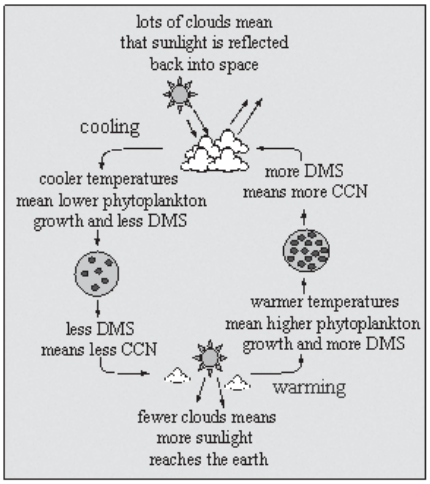
The evidence of Krakatoa, and other disturbed or virgin ecosystems, shows that the initial colonization by *pioneer* or *R strategy* species occurs through positive feedback reproduction strategies, wherein species are like weeds, producing huge numbers of possible offspring, but investing little in the success of any one. Rapid boom and bust plague or pest cycles are observed with such species. As an ecosystem starts to approach climax, these species get replaced by more sophisticated climax species, which, through negative feedback, adapt themselves to specific environmental conditions. These species, closely controlled by *carrying capacity*, follow *K strategies*, wherein species produce fewer numbers of potential offspring, but invest more heavily in securing the reproductive success of each one to the micro-environmental conditions of its specific ecological niche.

Such ecosystems form nested communities or *hierarchies* (also see Hierarchy theory), in which homeostasis at one level contributes to homeostatic processes at another holonic level. Forest glades provide ecological services, such as the regulation of microclimates or of the hydrological cycle for an ecosystem, and a number of different ecosystems act together to maintain homeostasis, perhaps of a number of river catchments within a bioregion. A diversity of bioregions, in like manner, makes up a stable homeostatic biological region or biome.

Adapted from: http://en.wikipedia.org/wiki/Homeostasis (accessed:02-01-2009)

2.7 The CLAW and Anti-CLAW Hypotheses

In 1987, Robert Charlson and his colleagues suggested that phytoplankton do not just simply affect climate by producing the gas dimethyl sulphide (DMS) but actually play a role in regulating the climate of the Earth. The CLAW hypothesis (named after the authors of the paper[1]) is an example of a negative feedback loop where some mechanism acts to counteract the initial change in such



a way to maintain the *status quo*. Positive feedback occurs when the initial change is amplified by subsequent processes.

The hypothesis describes a feedback loop that begins with an increase in the available energy from the sun acting to increase the growth rates of phytoplankton by either a physiological effect (due to elevated temperature) or enhanced photosynthesis (due to increased irradiance). Certain phytoplankton, such as coccolithophorids, synthesise dimethylsulfoniopropionate (DMSP), and their enhanced growth increases the production of this osmolyte. In turn, this leads to an increase in the concentration of its breakdown product, dimethyl sulfide (DMS), first in seawater, and then the atmosphere. DMS is oxidised in the atmosphere to form sulfur dioxide, and this leads to the production of sulfate aerosols. These aerosols act as cloud condensation nuclei and increase cloud droplet number, which in turn elevate the liquid water content of clouds and cloud area. This acts to increase cloud albedo, leading to greater reflection of incident sunlight, and a decrease in the forcing that initiated this chain of events.

Note that the feedback loop can operate in reverse, such that a decline in solar energy leads to reduced cloud cover and thus to an increase in the amount of solar energy reaching the Earth's surface. In a recent book, *The Revenge of Gaia*, Lovelock has proposed that instead of providing negative feedback in the climate system, the components of the CLAW hypothesis may act to create a positive feedback loop.

As such, the CLAW hypothesis posits an example of planetary-scale homeostasis or complex adaptive system, consistent with the Gaia hypothesis framed by one of the original authors of the CLAW hypothesis, James Lovelock.

All scientific studies conducted so far show that sulphate aerosols are important in climate control and models suggest that they do cause cooling. Ice cores, which give a record of the Earth's past, show that sulphate aerosol levels in the atmosphere have changed in phase with climate cycles over glacial and interglacial time scales. Recent studies have also shown that there is a link between DMS emissions and the number of cloud condensation nuclei (CCN) present in the atmosphere and that increases in the temperature of surface seawater do lead to increases in DMS concentrations in the air.

So we now have evidence that some of the steps within the CLAW hypothesis are correct but we still don't know whether the system really operates as a negative feedback loop. This makes it very difficult to represent the process in climate models and so we are still unsure quite how important DMS is to the cooling of our planet.

Under future global warming, increasing temperature may stratify the world ocean, decreasing the supply of nutrients from the deep ocean to its productive euphotic zone. Consequently, phytoplankton activity will decline with a concommitant fall in the production of DMS. In a reverse of the CLAW hypothesis, this decline in DMS production will lead to a decrease in cloud condensation nuclei and a fall in cloud albedo. The consequence of this will be further warming which may lead to even less DMS production (and further climate warming!).

Evidence for the anti-CLAW hypothesis is constrained by similar uncertainties as those of the sulfur cycle feedback loop of the CLAW hypothesis. However, researchers simulating future oceanic primary production have found evidence of declining production with increasing ocean stratification.

[1]R. **C**harlson, J. **L**ovelock, M. **A**ndreae and S. **W**arren (1987). Oceanic phytoplankton, atmospheric sulphur, cloud albedo and climate. *Nature*, 326, 655-661.

Adapted from: http://www.atmosphere.mpg.de/enid/1w1.html and http://en.wikipedia.org/wiki/CLAW_hypothesis#The_CLAW_hypothesis (accessed on 02-01-2009)

2.8 Understanding Hierarchy Theory

Hierarchy of human needs

The *Hierarchy Theory* is a dialect of general systems theory. It has emerged as part of a movement toward a general science of complexity. Rooted in the work of economist, Herbert Simon, chemist, Ilya Prigogine, and psychologist, Jean Piaget, hierarchy theory focuses upon levels of organization and issues of scale.

Hierarchies occur in social systems, biological structures, and in the biological taxonomies. Scholars as well as laypersons commonly use hierarchy and hierarchical concepts. Hierarchy theory uses a relatively small set of principles to keep track of the complex structure and behaviour of systems with multiple levels.

In mathematical terms, hierarchy is a partially ordered set. It is a collection of parts with ordered asymmetric relationships inside a whole. That is to say, upper levels are above lower levels, and the relationship upwards is asymmetric with the relationships downwards.

Hierarchical levels are populated by entities whose properties characterize the level in question. A given entity may belong to any number of levels, depending on the criteria used to link levels above and below. For example, an individual human being may be a member of the level i) human, ii) primate, iii) organism or iv) host of a parasite, depending on the relationship of the level in question to those above and below.

The **level of organization** fits into its hierarchy by virtue of set of definitions that lock the level in question to those above and below. For example, a biological population level is an aggregate of entities from the organism level of organization, but it is only so by definition. There is no particular scale involved in the population level of organization, in that some organisms are larger than some populations, as in the case of skin parasites.

Order, Hierarchy, Discipline.

-Benito Mussolini
Proposed national slogan

The **level of observation** fits into its hierarchy by virtue of relative scaling considerations. For example, the host of a skin parasite represents the context for the population of parasites; it is a landscape, even though the host may be seen as belonging to a level of organization, organism that is lower than the collection of parasites, a population.

When a system is observed, there are two separate considerations. One is the spatiotemporal scale at which the observations are made. The other is the **criterion for observation**, which defines the system in the foreground away from all the rest in the background.

Based on the criteria there is an **ordering of levels** whereby some levels reside above lower levels. Upper levels are above lower levels by virtue of: 1) being the context of, 2) offering constraint to, 3) behaving more slowly at a lower frequency than, 4) being populated by entities with greater integrity and higher bond strength than, and 5), containing and being made of - lower levels.

Nested hierarchies involve levels which consist of, and contain, lower levels. **Non-nested hierarchies** are more general in that the requirement of containment of lower levels is relaxed. An army is a nested hierarchy. On the other hand, the general at the top of a military command does not consist of his soldiers and so is a non-nested hierarchy with regard to the soldiers in the army. Pecking orders and food chains are also non-nested hierarchies.

The **dualism in hierarchies** appears to come from a set of complementarities that line up with: observer-observed, process-structure, rate-dependent versus rate-independent, and part-whole. Arthur Koestler in his *Ghost in The Machine* referred to the notion of *holon*, which means an entity in a hierarchy that is at once a whole and at the same time a part. Thus a holon at once operates as a quasi-autonomous whole that integrates its parts, while working to integrate itself into an upper level purpose or role.

The concept of hierarchy becomes confused unless one makes the distinction between limits from below and limits from above. The **limits of possibility** come from lower levels in the hierarchy. What is allowed by the upper level is **constraint**.

As a system becomes more elaborately hierarchical its behavior becomes **simple**. The reason is that, with the emergence of intermediate levels, the lowest level entities become constrained to be far from equilibrium. Deep hier-

archical structure indicates elaborate organization, and deep hierarchies are often considered as **complex** systems by virtue of hierarchical depth.

Hierarchy theory is as much as anything a theory of observation. It has been significantly operationalized in ecology, but has been applied relatively infrequently outside that science.

Adapted from: http://www.isss.org/hierarchy.htm (accessed on 09-01-09)

2.9 Entropy and Emergence

Entropy is a measure of the bound energy of a system. In a system with a high level of entropy, most or all of its energy is bound; in one with a low level of entropy, the opposite is true. The degradation of energy from free to bound form has also been referred to as a turning of order into disorder. In an ordered structure, energy is free, while a structure with bound energy is chaotic and disordered.

The term "entropy" was first introduced by German physicist Rudolf Clausius more than 100 years ago. Essentially it describes the movement of any system toward disorder. However, Nicholas Georgescu-Roegen, in his famous work *The Entropy Law and the Economic Process* extended its meaning and implication in the economic systems.

Georgescu-Roegen illustrates entropy with a simple example of coal being used to run a railway engine. At the beginning of the process before burning, the chemical energy of the coal is free, in the sense that it is available to us for producing some mechanical work. In the process, however, the free energy loses this quality, bit by bit. Ultimately, it always dissipates completely into the whole system where it becomes *bound* energy; that is energy that we can no longer use for any purpose.

Life has the capacity to oppose the qualitative degradation to which inert matter is subject. In fact, life may be characterized as the capacity to create order, to create free energy, to create diversity, and to evade the law of entropy. Georgescu-Roegen has called the principle that allows life to create new patterns "the principle of emergence of novelty by combination." Living energies allow us to break out of the predictable destructiveness and dissipation inherent to mechanical energy. They create new material possibilities for well being without ecological destruction. We become co-creators or co-producers with nature's creative renewing processes.

As eminent development biologist Brian Goodwin points out: "It is now recognized that emergent properties are very widespread in nature, particularly in living systems. Many of the most intriguing characteristics of life, such as the way a complex organism emerges from the interaction of many cells during embryonic development, or the patterns of species extinctions during evolution, are unexpected results of particular patterns of interaction between components in complex systems."

Such emergence is characteristic of all living systems. When society is organized on the basis of the living energy of its citizens, living democracy is an emergent phenomenon, making the impossible possible, creating hope out of hopelessness, unleashing our creative energies in the midst of ecological and social ruin.

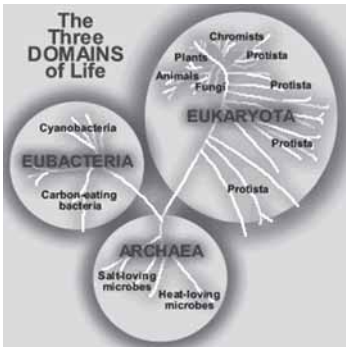
Human beings, as living beings, have a choice between two alternatives – the entropic option or an emergent option. The high-entropy journey humanity has undertaken under the illusion of growth and progress does not have a future. We will have to change the road we are on, and we will have to change our goals. The goals cannot be set by reductionist science, industrial technologies, and neoliberal economies. The goals cannot be narrowly defined as economic growth or consumerism. The goals have to be the preservation of the earth, her diverse species, and future generations.

Climate chaos, brutal economic inequality, and social disintegration are jointly pushing human communities to the brink. We can either let the processes of destruction, disintegration, and extermination continue unchallenged, or we can unleash our creative energies to make systemic change and reclaim our future as a species, as part of the earth family. We can either keep sleepwalking to extinction or wake up to the potential of the planet and ourselves.

Adapted from: http://www.ecoliteracy.org/publications/vandana_shiva.html (accessed on 09-01-2009)

2.10 Three Domains of Life

With the discovery of the uniqueness of Archaebacteria in rRNA sequence and by comparative studies with well-characterized molecular systems, cell walls, lipid compositions and features of the transcriptional and translational machineries, the three domains of life, namely Archaea, Bacteria and Eukarya, has become the currently accepted paradigm in the field of molecular taxonomy. Sequence analyses based on functional proteins across the three domains also suggest each of the three domains as independent monophyletic lineage representing ribosomal, metabolic, biosynthetic proteins as well as the replicational, transcriptional and translational machineries.



Current view suggests that the universal tree of life branched from the universal ancestor in separate lineages leading to Bacteria and Archaea, the latter then diverged into Eukarya. The search for the universal ancestor has led to postulating a universal communal gene pool (*progenotes)* in which lateral or horizontal gene transfer (HGT) played the most important role in diversification since the three domains of life are resistant to HGT after they have crystallized into cellular communities. This scenario challenges the concept of the Universal Cellular Ancestor and may be open to alternative views based on design.

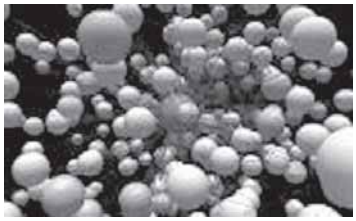
Adapted from: http://www.iscid.org/papers/Pun_ThreeDomains_072602.pdf (Accessed on 08-01-2009)

2.11 No gene is an island

Understanding secrets of life is still an unending challenge to scientists. Even as biologists catalogue the discrete parts of life forms, an emerging picture reveals that life's functions arise from interconnectedness. Genes and proteins interact in a complex, crisscrossing pattern to steer cells' behaviour during different situations.

The gene *p53* has long been singled out as an anticancer hero, a critical tumour fighter. A person or lab animal develops a tumour much faster without the gene than with it. But *p53* could be dangerous if left to act alone. What really gives

the gene its power is its network within a cell. Cells must guard against the constant threat of becoming cancerous, a change sometimes triggered by damage to the cells' DNA. The *p53* gene is embedded in a network of interacting genes and proteins, and this web of interactions provides sophisticated control of *p53*, keeping it in check. Such control is important because *p53* is a double-edged sword: It can either promote DNA repair or -if the DNA damage is too severe-trigger the cancer-prone cell to self-destruct (thus sparing the rest of the body from getting cancer). Balancing these two functions is critical for keeping cancer at bay.



And a cell's behaviour is crucial to its survival. Whether a single cell floating in the sea or a cell within a plant or person, a cell must do the right thing at the right time in the right way or it might simply die. Whatever the cell's fancy internal mechanisms may be, the end result—the cell's behaviour—is all that matters.

By looking at how all the parts of a cell are networked, researchers are finding sub networks that behave much like basic components of electronic circuits, such as switches, blinkers and buzzers. Recent works suggests that entire cell networks balance themselves at the threshold, separating order from chaos.

When applied to an organism's inner workings, a network perspective can solve problems that a gene-centric approach can't—such as understanding the growth of a sea urchin embryo or how the segmentation of insect bodies is encoded. Many scientists also think that understanding human cells at the network level is essential for developing drugs to treat complex diseases such as diabetes and cancer.

Networks are full of surprises as they often behave in an unexpected fashion. That's because networks are more than the sum of their parts. A network's architecture—the pattern of interactions among its parts—strongly influences its overall behaviour in ways that can't be predicted based on the parts alone. And some connection patterns give rise to nonintuitive, nonlinear behaviours.

Basic network diagrams looks a bit like a game of 'connect the dots' that end in a jumbled mess instead of a pretty picture. In a diagram, each dot represents a certain gene or protein, and a line between dots means that those two parts interact in some way. Perhaps one gene activates another, or a protein binds to and inhibits another protein. The complexity of protein interaction networks can be understood in terms of these little motifs that are hooked together. The right "motif," or pattern of connections among a few proteins, will behave like a switch, buzzer, sniffer or blinker. Combining even a few such motifs in a small sub-network can generate useful behaviours. For example, the tumour-suppressor gene *p53* is controlled by just a few motifs that combine to make *p53* behave much like a ticking time bomb.

Genes carry the codes for specific proteins, and the amount of a protein that a gene makes at any time is defined as the gene's activity. After DNA damage occurs in a cell, *p53* springs to life, and its activity—and thus the concentration of the p53 protein it encodes—begins to oscillate slowly from more to less and back again, like a throbbing warning light. The number of oscillations depends

on how bad the damage is. If the DNA hasn't been fixed by the time the oscillations stop, *p53* activity begins to ramp up slowly and steadily until it reaches a point that triggers the cell's suicide machinery.

In a network diagram, *p53* is connected with two other genes, *MDM2* and *ATM*, in a motif that could be called a damper: a negative feedback loop. The classic example of this kind of feedback loop is as in a thermostat. For genes in a network, a similar motif occurs when one gene activates another gene, which in turns inhibits the first gene.

Negative feedback loops with *MDM2* and *ATM* can explain *p53*'s oscillation behaviour after DNA damage. As time runs out, a second part of the network—a positive feedback loop between *p53* and the genes *PTEN*, *PIP3* and *Akt*—overcomes this first motif. Positive feedback loops could be called amplifiers: They cause an increase to keep increasing. Genes in this second motif cut off the damper by blocking the connection between *MDM2* and *p53*. This change switches off the thermostat, so the positive feedback loop can drive up *p53* activity until it triggers cell suicide.

The series of finding in this area reveal the hidden dynamics that emerge when genes and proteins act together in networks. But even after the mammoth task of thoroughly mapping the networks in a human cell is done, still to be understood is how that cell's networks integrate into a larger, different kind of network: the billions of interacting cells in an organ such as the heart or—shudder—the brain.

Adapted from: http://www.sciencenews.org/view/feature/id/38750/title/No_gene_is_an_island (accessed on 09-01-09)

God has lent us the earth for our life; it is a great entail. It belongs as much to those who are to come after us, and whose names are already written in the book of creation, as to us; and we have no right, by anything that we do or neglect, to involve them in unnecessary penalties or deprive them of the benefits which it is in our power to bequeath.

-John Ruskin,
The Seven Lamps of Architecture, 1849

A scientist has a lot of experience with ignorance and doubt and uncertainty... We have found it of paramount importance that in order to progress we must recognize our ignorance and leave room for doubt. Scientific knowledge is a body of statements of varying degrees of certainty- some most unsure, some nearly sure, but none absolutely certain… It is our responsibility as scientists, knowing the great progress which comes from a satisfactory philosophy of ignorance, to tech how doubt is not to be feared but welcomed and discussed.

-Richard Feynman

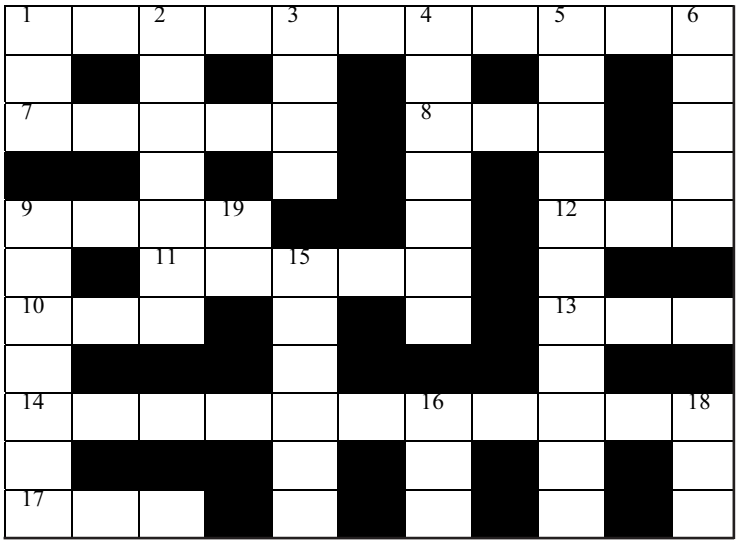
3.1 OCEAN IN PERIL QUIZ

A recent publication of the Worldwatch Institute gives a detailed account of the world's ailing oceans and what we can do to help them heal. From overfishing to aquaculture, nuclear waste to climate change, and litter to oil spill, many human activities are having adverse effects on the oceans and its rich, diverse and colourful life. This quiz is to test your eco-literacy on the diversity of the oceans and our growing footprint on them. Take this quiz and then read *Oceans in Peril: Protecting Marine Biodiversity,* to learn more.

1. Of the 33 animal phyla that exist, how many occur in the sea?
   a) 33 b) 32 c) 28 d) 18
2. What percentage of marine fish species inhabits coral reefs?
   a) 10 b) 25 c) 40 d) 60
3. Roughly how many people rely on coral reefs for their daily sustenance?
   a) 3 million b) 10 million c) 30 million d) 100 million
4. In Indonesia, a study showed that coral reefs suffered 30 to 60 percent reduction in species diversity due to:
   a) Sea level rise b) Pollution stresses c) Intensive aquaculture
   d) Failure to protect coastal mangrove
5. What percentage of marine debris is from land-based sources?
   a) 80 b) 59 c) 72 d) 35
6. Since the age of industrialization began, the oceans have absorbed what percentage of human caused CO_2 emissions?
   a) 0 b) 10 c) 50 d) 65
7. More than a third of the fish used to make fishmeal world-wide goes into producing:
   a) Feeds for aquaculture b) Feeds for factory farming c) Fertilizer
   d) Pet food
8. Which is not a threat of aquaculture to marine ecosystem?
   a) Depletion of wild stocks for feed or seed b) Longline fishing c) Chemical contamination d) Introduction of diseases
9. Which of the following is true for mangroves?
   a) They support an estimated 80 percent of all marine species of commercial or recreational value in Florida, b) Large-scale mangrove destruction is a relatively recent phenomenon, c) Loss of mangrove forests has resulted in the release of large quantities of stored carbon, contributing to human-induced climate change, d) All the above.
10. What percentage of the world's ocean is currently protected in marine reserves (effectively "National Parks" of the seas)?
    a) 1 b) 5 c) 10 d) 50

Now turn to Page 43 for answers

3.2 MARINE CROSS WORD



ACROSS

1. A layer of water between warm surface water and cool deep water where the temperature decreases rapidly with depth (11).
7. A term describing collectively all living organisms in a habitat (5).
8. The acronym for a device used for allowing escape of turtle accidentally captured in trawl nets (3).
9. The facility in a microscope or camera for continuously increasing the magnification (4).
10. An acronym indicating in economic terms the sustainable yield from a fishery or a renewable natural resource (3).
11. The basic unit of transfer of hereditary information in living organisms (5).
12. That part of the earth system having constant interaction with the oceans (3).
13. The number of females in a cluster or harem of clown fishes (3).
14. A fish which can produce electricity sufficient to light up an incandescent bulb (8,3)
17. A substance released as a defensive ploy by a common shellfish(3)

DOWN

1. You find this on a keyboard (3)
2. The mother of all sciences (7)
3. A measure of central tendencies in statistics (5)
4. Males of this marine fish brood the eggs in their buccal cavity (7)
5. The only ocean named after a country (6,5)
6. A young of a fish commonly associated with a common seaweed (6).
9. This major river in Africa empties into the Indian Ocean (7).

15. Marine or freshwater organisms that can swim freely, generally independent of currents, ranging in size from microscopic organisms to whales (6).
16. A pleomorphic state of matter, a major part of the oceans in the higher latitudes (3).
18. An acronym indicating a dimension of a boat or ship (3).
19. The first two letters of the acronym for the present international symposium (2).

Now turn to Page 72 for answers

3.3 MARINE WORD GAME

Feeling bored? Well, here's something you can do. Hidden among this pack of alphabets are the following 51 words. They are in straight line in all eight directions (horizontally, vertically or diagonally). Can you locate them? Take a pen and get going…right? If you can find all of them in 15 minutes, you are a genius! Try your luck!

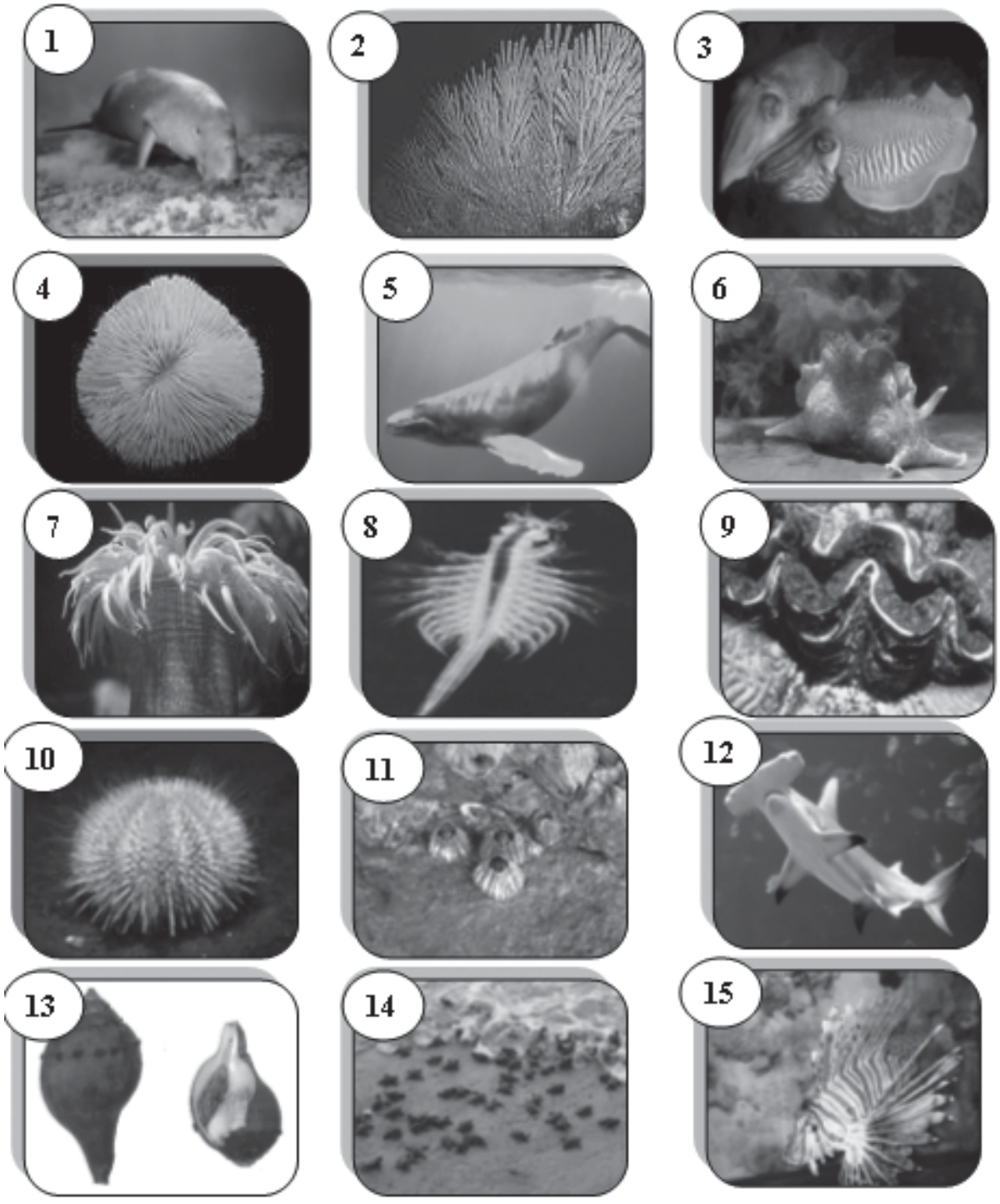
CURRENT	SEAL	GULF	RAFT	WALRUS	ECHO	BEACH
GILLNET	NOAA	REN	ROW	CATCH	TRAP	WASH
INDIAN OCEAN	CRAB	ICE	SEA	OZONE	NEST	TUNA
OIL SPILL	SEAL	DART	IUCN	FLOAT	INDIA	CORAL
PEARL	GIG	TED	SHIP	NOZZLE	TERN	ATOLL
EL NINO	NGO	EEZ	ARTIC	TURTLE	WHALE	DIVER
DOLPHIN	FAD	EEL	EAR	ANCHOR	TIDE	PUFA
WAVE	LOW					

JUMBLED PACK OF ALPHABETS

I	S	A	F	L	U	G	G	I	L	L	N	E	T
S	N	E	T	T	I	N	G	F	L	O	A	T	T
A	E	D	U	G	O	N	G	O	H	E	E	F	A
N	N	A	I	E	D	I	T	U	N	A	A	L	W
C	I	A	L	A	W	A	T	O	E	R	A	O	H
H	H	E	A	N	N	O	Z	Z	L	E	E	W	A
O	P	P	R	T	O	O	I	L	S	P	I	L	L
R	L	U	O	A	A	S	C	A	T	C	H	W	E
E	O	F	C	R	A	B	P	E	A	R	L	S	S
R	D	A	R	T	R	A	P	V	A	E	C	H	O
A	I	D	N	I	U	C	N	R	A	N	D	I	C
R	V	W	Z	C	U	R	R	E	N	T	A	P	H
T	E	R	N	E	S	T	T	W	A	L	R	U	S
I	R	E	H	T	E	O	E	L	N	I	N	O	A
C	B	E	A	C	H	L	D	A	E	V	A	W	W

3.4 MARINE PICTURE QUIZ

Can you recognize our friends from Marine Ecosystem?



Now turn to Page 72 for answers

4.1 Ecosystem – Some Concepts

Biome and Ecosystem

When someone asks the difference between an ecosystem and a biome, most of us are confused. There is a slight difference, an ecosystem is much smaller than a biome. Conversely, a biome can be thought of many similar ecosystems throughout the world grouped together. An ecosystem can be as large as the Sahara Desert, or as small as a puddle or vernal pool. Examples of biome are tundras, temperate forests, islands, deserts, grassland, savannas and tropical rainforests.

Ecosystems connote dynamic interactions between plants, animals, and microorganisms and their environment working together as a functional unit. It is composed of biotic communities and abiotic environmental factors, which form a self-regulating and self-sustaining unit. Different ecosystems contain species that are adapted to its varying conditions of water, heat, and soil. For instance, polar bears thrive in the arctic while cactus plants flourish in the hot deserts. In an ecosystem, each organism has its own niche, or role to play. No ecosystem can carry more organisms than its food, water, and shelter can accommodate. The different components of an ecosystem are kept in balance by various cyclic processes and natural phenomena such as fire, disease, predation etc. Ecosystems will collapse if the balance is irreversibly disturbed.

Aquatic Ecosystems

An aquatic ecosystem is an ecosystem located in water bodies. Communities of organisms that require aquatic environment for life and reproduction live in aquatic ecosystems. The two main types of aquatic ecosystems are marine ecosystems and freshwater ecosystems.

Marine ecosystems cover approximately 71% of the Earth's surface and contain approximately 97% of the planet's water. They are distinguished from freshwater ecosystems by the presence of dissolved compounds, especially salts, in the water. Approximately 85% of the dissolved materials in seawater are sodium and chlorine. Seawater has an average salinity of 35 parts per thousand (ppt) of water. Actual salinity varies among different marine ecosystems. The marine ecosystems account for about 32% of the world's net primary production. They include oceans, salt marsh and intertidal areas, estuaries and lagoons, mangroves and coral reefs, the deep sea and the sea floor.

We need nature more than nature needs us

-Sadruddin Aga Khan,
Spiritual leader of Ismaili sect of Shiite Muslims, 1991

Freshwater ecosystems cover 0.8% of the Earth's surface and contain 0.009% of its total water. They generate nearly 3% of its net primary production. Freshwater ecosystems contain 41% of the world's known fish species. There are three basic types of freshwater ecosystems namely lentic (slow-moving water), lotic (rapidly-moving water) and wetlands.

Ecosystem Functions

Aquatic ecosystems perform many important environmental functions. For example, they recycle nutrients, purify water, attenuate floods, recharge ground water and provide habitats for wildlife. Aquatic ecosystems are also used for human recreation, and are very important to the tourism industry, especially in coastal regions.

The health of an aquatic ecosystem is maintained by various balancing processes within its boundary. A stress on an aquatic ecosystem can be a result of physical, chemical or biological alterations of the environment. Physical alterations include changes in water temperature, water flow and light availability. Chemical alterations include changes in the loading rates of biostimulatory nutrients, oxygen consuming materials, and toxins. Biological alterations include the introduction of exotic species. Human populations can impose excessive stresses on aquatic ecosystems. Any such stress which could not be nullified by the balancing process would degrade the health of the ecosystem.

Abiotic characteristics

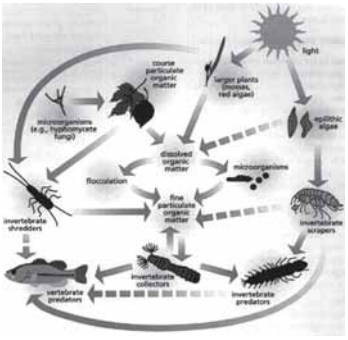
Abiotic environmental factors of aquatic ecosystems include temperature, salinity, dissolved gases and nutrients, currents and flow etc. The amount of dissolved oxygen in water is the key factor in determining the extent and kinds of organic life in the water body. Most organisms need dissolved oxygen to survive whereas, oxygen is fatal to many kinds of anaerobic bacteria. The salinity of the water is also a factor determining in the kinds of species found in a water body. Organisms in marine ecosystems can tolerate salinity (Euryhaline), while many freshwater organisms are intolerant (Stenohaline) of salt.

Biotic characteristics

The organisms (also called biota) found in aquatic ecosystems are either autotrophic or heterotrophic. Autotrophic organisms are primary producers that generate organic compounds from inorganic material. Algae use solar energy to produce carbohydrates from carbon dioxide and are the most important autotrophic organisms in aquatic environments. Chemosynthetic bacteria found in benthic marine ecosystems are able to utilize hydrogen sulfide in water that comes from volcanic vents. Great concentrations of animals that feed on these bacteria are found around volcanic vents. For example, there are giant tube worms (*Riftia pachyptila*) 1.5 m in length and clams (*Calyptogena magnifica*) 30 cm long. Heterotrophic organisms consume autotrophic organisms and use the organic compounds in their bodies as energy sources and as raw materials to create their own biomass.

The Food Web

A popular misnomer, the 'food chain' is not actually a linear chain but a complex web. Energy is passed from one organism to another in a complex network like a spider's web.



Starting with the source of energy, the food web consists of four main parts namely the sun, producers, consumers and decomposers. The Sun is the source of energy for everything on the planet. Producers include all green plants, also known as autotrophs, since they make their own food. Producers are able to harness the energy of the sun to make food. Ultimately, every (aerobic) organism is dependent on plants for oxygen (which is the waste product from photosynthesis) and food (which is produced in the form of glucose through

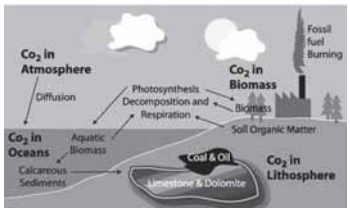
photosynthesis). They make up starting point in the food web and account for the bulk of the biomass on the Earth.

Consumers are heterotrophs which consume some other organisms or products form other organisms. They include herbivores (animals that eat plants), carnivores (animals that eat other animals), parasites (animals that live off of other organisms), and scavengers (animals that eat dead animal carcasses). Primary consumers are the herbivores, and are the second largest biomass in an ecosystem. The animals that eat the herbivores (carnivores) make up the third largest biomass, and are also known as secondary consumers. This continues with tertiary consumers, etc.

Decomposers are mainly bacteria and fungi that convert dead matter into gases such as carbon and nitrogen to be released back into the air, soil, or water. The fungi, and other organisms that break down dead organic matter are known as saprophytes. Decomposers are necessary since they recycle the nutrients to be used again by producers, in their absence the earth would be covered in trash.

Some human activities tamper with the links in the food web (e.g. pesticides killing insects), putting all the organisms above that link to threat of extinction (like the domino effect). By hunting an animal nearly to extinction, everything above the animal in the food chain is put in danger and those below are allowed to flourish without control. Meddling with food web can bring 'chain reactions' which can be perilous to the ecosystem.

The Carbon Cycle

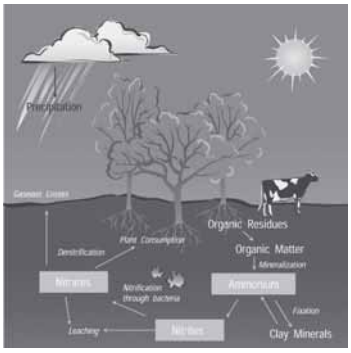


Carbon is so special because of its ability to bond to almost any other molecule and it is the major element in the organic world. Carbon forms the basis of all organic molecules like carbohydrates, fats, proteins, genetic materials that make the living organisms.

The carbon cycle is the process by which carbon circulates in a cyclic manner through the air, ground, plants, animals, and fossil fuels etc in different forms. Large amounts of carbon exist in the atmosphere as carbon dioxide (CO_2) which is absorbed by green plants during photosynthesis to make organic molecules (glucose, which is food). Consumers burn this molecules and decomposers break down dead organic matter to release carbon dioxide into the air. Decomposers are essential because without them, all of the carbon on the planet would eventually become locked up in dead carcasses and other trash. Decay permits carbon to be released back into atmosphere and into the food web. Carbon is also stored in fossil fuels (compressed organic matter), such as coal, petroleum, and natural gas. When these are burned, carbon dioxide is also released back into the air. Volcanoes and fires also release large amounts of CO_2 into the atmosphere.

Human society drastically altered the carbon cycle by destroying forests and other forms of vegetation (which absorbed CO_2) without replanting and at the same time releasing carbon dioxide by excessive burning of fossil fuel.

The Nitrogen Cycle

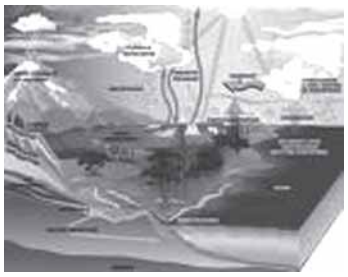


Nitrogen forms several organic molecules such as amino acids, proteins, DNA etc. which are important components of all living cells. Nitrogen is the major component of earth's atmosphere and it enters the biological systems by the action of nitrogen-fixing bacteria and algae in the soil. The nitrogen-fixing bacteria transform the atmospheric nitrogen into nitrate which when dissolved in soil water can be taken up by the roots of plants. Then, the nitrates are incorporated by the plants in the different organic compounds like proteins, which then pass through the food web. When the organisms excrete metabolic wastes, or when they die and decompose, nitrogen compounds like ammonia are released into the environment. These compounds may be reused by plants or bacterial activity will convert it to gaseous nitrogen, which returns back to atmosphere.

Several human activities such as dumping of raw sewage containing nitrogenous wastes along with urban runoff, cause nitrogen overload in an ecosystem. When large amounts of nitrogen collect in a water body there are many ill-effects such as eutrophication. This algal bloom due to accumulation of excess nutrients will cause rapid depletion of oxygen in the water, making it inhospitable for fish and other aquatic organisms. Excessive nutrient loading in the oceans will sometime cause the deadly red tides.

Burning of fossil fuels and wood results in the emission of a large amount of nitric oxide into the atmosphere. Nitric oxide can combine with oxygen gas to for nitrogen dioxide, which reacts with water vapor to form a strong acid (nitric acid). This can precipitate out of the atmosphere in the form of the deadly acid rain. The acid can damage vegetation and cause fish kill. Excessive use of inorganic fertilizers and depletion the natural agents in nitrogen cycle such as leguminous plants are not desirable for a healthy ecosystem.

The Water Cycle



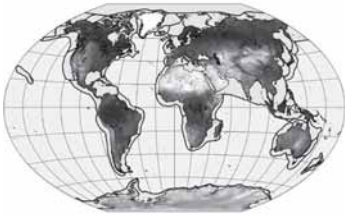
The water cycle, also known as the hydrologic cycle, involves the cycling of water through the Earth systems. Water naturally exists in 3 forms: solid, liquid, and gas. Water continuously changes these forms while cycling through different systems and regions. From the surface of the Earth, water enters the atmosphere by evaporation. In the atmosphere it exists as water vapor or as clouds, when condensed. On precipitation it comes down as rain and on the ground it exists as liquid water on the earth surface (rivers, lakes, and ocean) or underground (groundwater). In cooler areas it exists as snow, sleet, hail, ice etc. This cyclic process repeats itself over and over and every drop of water on the Earth winds up moving through it. At any given time just .005 percent of the world's total water supply is moving through the cycle. A drop of water will usually spend 9 days in it but, once it falls on the Earth surface, it can spend anywhere from 40 years (in a glacier) to 40,000 years (in the ocean) before going into the cycle.

Interesting facts about water

- Water is the only substance on earth which exists in three different forms; liquid, solid and a gas.
- The density of ice is less than water; that is why icebergs float on water.
- Water has the highest surface tension of all liquids. Precipitation is possible because water can form a 'skin'.
- There is no force which exists that can compress water, meaning nothing could press water into an ice cube.
- Water is the 'universal solvent'; it dissolves more substances than any other liquid.
- Worldwide, over 36,000 dams have been built to generate hydroelectric power, provide drinking water, irrigation, industrial supplies and control floods.
- Nearly 1.2 billion people worldwide are at risk from drinking water contamination.
- If 4 percent of the world's military expenditures (36 billion dollars) were saved each year, all of humanity would have clean drinking water and a sanitary way of disposing waste.
- The energy required for running the Earth's hydrologic cycle for one day exceeds the total energy that human society has created throughout its entire history.
- The wettest part of our body, the blood, contains 83 percent water, while our tooth enamel, the driest part of our body, contains 2 percent water.
- Russia's Lake Baikal is the largest (5,712 feet deep, 812 billion cubic feet) freshwater lake in the world and the oldest (30 million years). It supports 60 of species that occur nowhere else on earth, the highest proportion anywhere.

Adapted from: http://thinkquest.org (accessed 02 January 2009).

4.2 Large Marine Ecosystems (LMEs)



Large Marine Ecosystems (LMEs) are regions of the world's oceans, encompassing coastal areas from river basins and estuaries to the seaward boundaries of continental shelves and the outer margins of the major ocean current systems. They are relatively large regions on the order of 200,000 km^2 or greater, characterized by distinct bathymetry, hydrography, productivity, and trophically dependent populations. The system of LMEs has been developed by the US National Oceanic and Atmospheric Administration (NOAA) to identify areas of the oceans for conservation purposes.

Although the LMEs cover only the continental margins and not the deep oceans and oceanic islands, the 64 LMEs produce 95% of the world's annual marine fishery biomass yields. Most of the global ocean pollution, overexploitation, and coastal habitat alteration occur within the LMEs.

List of Large Marine Ecosystems

East Bering Sea	Red Sea
Gulf of Alaska	Bay of Bengal
California Current	Gulf of Thailand
Gulf of California	South China Sea
Gulf of Mexico	Sulu-Celebes Sea
Southeast U.S. Continental Shelf	Indonesian Sea
Northeast U.S. Continental Shelf	North Australian Shelf
Scotian Shelf	Northeast Australian Shelf/Great Barrier Reef
Newfoundland-Labrador Shelf	East-Central Australian Shelf
Insular Pacific-Hawaiian	Southeast Australian Shelf
Pacific Central-American Coastal	Southwest Australian Shelf
Caribbean Sea	West-Central Australian Shelf
Humboldt Current	Northwest Australian Shelf
Patagonian Shelf	New Zealand Shelf
South Brazil Shelf	East China Sea
East Brazil Shelf	Yellow Sea
North Brazil Shelf	Kuroshio Current
West Greenland Shelf	Sea of Japan
East Greenland Shelf	Oyashio Current
Barents Sea	Sea of Okhotsk
Norwegian Shelf	West Bering Sea
North Sea	Chukchi Sea
Baltic Sea	Beaufort Sea
Celtic-Biscay Shelf	East Siberian Sea
Iberian Coastal	Laptev Sea
Mediterranean Sea	Kara Sea
Canary Current	Iceland Shelf
Guinea Current	Faroe Plateau
Benguela Current	Antarctica
Agulhas Current	Black Sea
Somali Coastal Current	Hudson Bay
Arabian Sea	Arctic Ocean

LMEs of the Indian Ocean

There are two LMEs in the Indian Ocean, the Arabian Sea and the Bay of Bengal. The Arabian Sea is a region of the Indian Ocean bounded on the east by India, on the north by Pakistan and Iran, on the west by Arabian Peninsula, on the south, approximately, by a line between Cape Guardafui, the north-east point of Somalia, Socotra, Kanyakumari (Cape Comorin) in India, and the western coast of Sri Lanka. The maximum width of the

Arabian Sea is approximately 2,400 km (1,490 mi), and its maximum depth is 4,652 metres (15,262 ft), in the Arabian Basin, approximately at the same latitude as the southernmost tip of India. The Indus River, the largest river in Pakistan, also known as the Sindhu river, is the largest river flowing directly into this sea; others include the Netravathi, Sharavathi, Narmada, Tapti, Mahi, and the numerous rivers of Kerala in India. The Arabian Sea coast of central India is known as the Konkan Coast, and that of southern India is known as the Malabar Coast.

The Bay of Bengal is the triangular shaped bay that forms the northeastern part of the Indian Ocean. It is bordered by India and Sri Lanka to the West, Bangladesh and India (Bengal: where the name comes from) to the North, and Myanmar, southern part of Thailand and the Andaman and Nicobar Islands to the East. Its southern boundary extends as an imaginary line from Dondra Head at the southern end of Sri Lanka to the northern tip of Sumatra.

The Bay of Bengal occupies an area of 2,172,000 km². A number of large rivers – Ganges, Brahmaputra, Padma, Meghna, Jamuna, Ayeyarwady, Godavari, Mahanadi, Krishna and Kaveri – flow into the Bay of Bengal. Among the important ports are Cuddalore, Chennai, Kakinada, Tuticorin, Machilipatnam, Vishakapatnam, Paradip, Kolkata, Chittagong and Yangon.

Adapted from: http://en.wikipedia.org/wiki/large_marine_ecosystem

4.3 Primary Production

The production of organic compounds from atmospheric or aquatic carbon dioxide, principally through the process of photosynthesis (and to a minute extent by chemosynthesis) is broadly termed as primary production. All life on earth is directly or indirectly reliant on primary production. The organisms responsible for primary production are known as primary producers or autotrophs, and form the base of the food chain. In terrestrial ecoregions plants are the main primary producers, while in aquatic ecoregions algae are the major primarily producers.

Primary production is often distinguished as gross and net, the former connote the total production and the latter the balance after accounting for losses due to cellular respiration etc. Gross primary production (GPP) is the rate at which producers capture and store a given amount of energy in the form of carbohydrate as biomass in a given period of time. Some fraction of this fixed energy is used by primary producers for cellular respiration and maintenance of

existing tissues. The remaining fixed energy is referred to as net primary production (NPP).

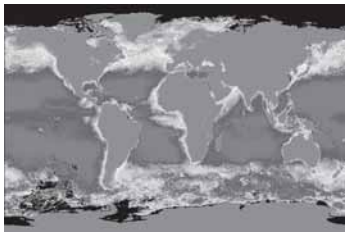
Thus, NPP = GPP - Respiration

Some net primary production will go towards growth and reproduction of primary producers, while some will be consumed by herbivores. Both gross and net primary production is represented in units of mass / area / time. In terrestrial ecosystems, mass of carbon per unit area per year (g $C/m^2/yr$) is most often used as the unit of measurement.

In the oceans, most of the primary production is by algae while a small fraction contributed by vascular plants (seagrasses) and other groups such as prokaryotic bacteria (both eubacteria and archaea). Algae encompass a diverse range of organisms, ranging from single celled planktons to attached seaweeds. Bulk of the primary production in the ocean is performed by the phytoplankton. Larger autotrophs, such as the seagrasses and macroalgal seaweeds are generally confined to the littoral zone and shallow waters, where they remain attached to the underlying substrate within the photic zone. There are exceptions, such as *Sargassum* which are found floating in open ocean.

Global Production

As primary production in the biosphere is an important part of the carbon cycle, estimating it at the global scale is very important. However, quantifying primary production at global scale is difficult because of the wide range of habitats on Earth, and variability of various controlling factors like light, rainfall etc.



Using satellite-derived estimates of the Normalized Difference Vegetation Index (NDVI) for terrestrial habitats and sea-surface chlorophyll for the oceans, it is estimated that the total (photoautotrophic) primary production for the Earth was 104.9 Giga tonnes C per year. Of this, 56.4 Gt C per year (53.8%) was the product of terrestrial organisms, while the remaining 48.5 Gt C per year was accounted for oceanic production.

Satellite-in situ blended ocean chlorophyll records indicate that global annual oceanic primary production has declined more than 6% since the early 1980's. Nearly 70% of the global decadal decline occurred in the high latitudes where the reductions in primary production corresponded with increases in sea surface temperature and decreases in atmospheric iron deposition to the oceans. In the Antarctic, the reductions were accompanied by increased wind stress. Three of four low latitude basins exhibited decadal increases in annual primary production. These results indicate that ocean photosynthetic uptake of carbon may be changing as a result of climatic changes and suggest major implications for the global carbon cycle.

(Adapted from: http://en.wikipedia.org/wiki/Primary_production
http://en.wikipedia.org/wiki/File: Seawifs_global_biosphere.jpg

4.4 Ecosystem-Based Management (EBM)

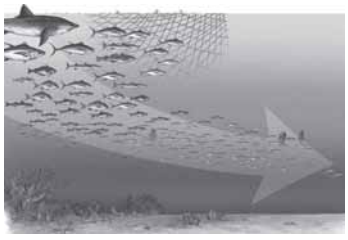
Ecosystem-Based Management (EBM) is a management approach that integrates ecological, social, and economic goals and recognizes humans as key components of the ecosystem. It considers ecological, not just political boundaries,

to addresses the complexity of natural processes and social systems and uses an adaptive management approach in the face of resulting uncertainties. The approach engages multiple stakeholders in a collaborative process to define problems and find solutions. It incorporates understanding of ecosystem processes and how ecosystems respond to environmental perturbations and is concerned with the ecological integrity of coastal-marine systems and the sustainability of both human and ecological systems.

In recent years there has been considerable interest in ecosystem-based fisheries management. The goal of ecosystem-based fisheries management is to maintain ecosystem health and sustainability. Ecosystem-based fishery management (EBFM) is a holistic approach to maintaining ecosystem quality and sustaining associated benefits. Sustaining the diverse products and services expected from marine ecosystems requires a broad interdisciplinary approach.

A three-step approach to implementation of EBFM consists of goals, metrics, and management. Setting policy goals is the important first step in the fishery-management process. Goals must be translated into clear quantifiable terms, i.e., metrics. Metrics, alternatively referred to as performance measures or reference points, are used to indicate the status of system attributes. Multiple metrics will generally be needed to account for diverse, and possibly conflicting, societal goals. Biotic metrics range from single-species to whole-system attributes. Abiotic metrics describe environmental conditions. Human metrics describe human activities and are essential for managing human impacts. These metrics can serve as the basis for decision criteria and reference points for the management process.

Fishing Down Marine Food Web



Several fisheries scientists have pointed out that modern marine fisheries tend to operate lower in the food web and had given various names to this trend ('biomass fishing', 'industrial fishing', 'exploiting forage fish', etc.). This trend was recently quantified, and given what might become its definite name – 'fishing down marine food webs' (FDMFW) in a report of the same name by Daniel Pauly and others published in *Science* (February 6, 1998. Vol. 279. no. 5352, pp. 860 – 863).

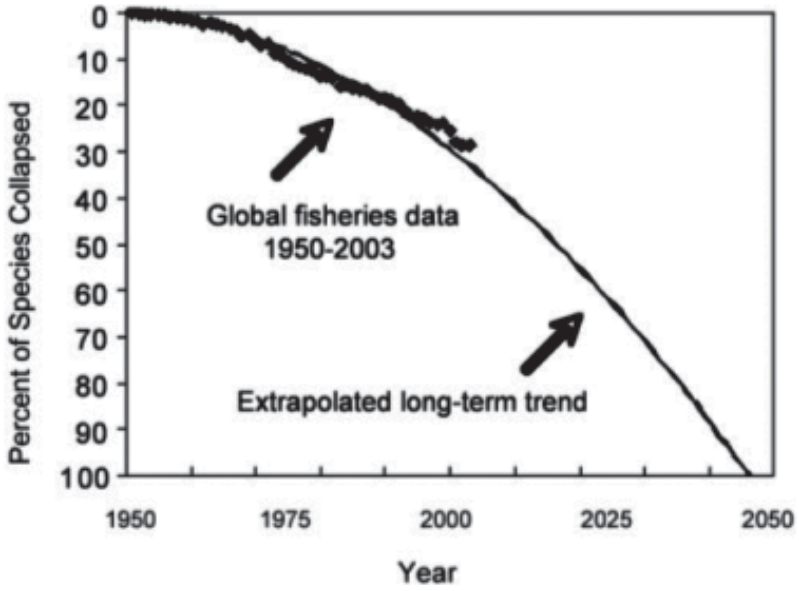
The mean trophic level of the species groups reported in FAO global fisheries statistics declined from 1950 to 1994. This reflects a gradual transition in landings from long-lived, high trophic level, piscivorous bottom fish toward short-lived, low trophic level invertebrates and planktivorous pelagic fish. This effect, also found to be occurring in inland fisheries, is most pronounced in the Northern Hemisphere. Fishing down food webs (that is, at lower trophic levels) leads at first to increasing catches, then to a phase transition associated with stagnating or declining catches. These results indicate that present exploitation patterns are unsustainable.

FDMFW relied on two sets of data: 1) Estimates of trophic levels of major species groups in global fisheries landings; and 2) Global fisheries catches, as compiled by the FAO as also incorporated in FishBase, the global database on fish.

Impacts of Biodiversity Loss

A recent paper by Boris Worm and others states that marine ecosystems are experiencing accelerating loss of populations and species, with largely unknown consequences. Overall, rates of resource collapse increased and recovery potential, stability, and water quality decreased exponentially with declining diversity. At current trends, the number of species surviving in the wild in oceans will decrease to zero by 2050. Restoration of biodiversity, in contrast, increased productivity fourfold and decreased variability by 21%, on average. They concluded that marine biodiversity loss is increasingly impairing the ocean's capacity to provide food, maintain water quality, and recover from perturbations. Yet available data suggested that at this point, these trends are still reversible.

The picture is same for a tide pool or the entire world ocean. In losing species we lose the productivity and stability of entire ecosystems. This sad picture emerged over four years of analyzing 32 controlled experiments, observational studies from 48 marine protected areas and global catch data from the FAO database from 1950 to 2003. The scientists also looked at a 1000-year time series for 12 coastal regions, drawing on data from archives, fishery records, sediment cores and archeological data. What makes recovery harder is that in areas where there are already few species (like the Arctic), the depletion of another species has serious consequences. Fortunately recovering a species has a profound positive impact.



http://www.sciencemag. org/cgi/contents/abstract/314/5800/787
http://blogsci.com/science/no-fish-by-2050

Trophic levels as indicator

There are many ways an ecosystem can be described perhaps the most straight forward way to describe is in terms of the feeding interactions among their

component species, by studying their stomach contents. A vast historical database of such published information exits which has enabled a number of generalizations to be made for EBFM. Thus in marine fisheries we have algae in the bottom of the food web (TL=1), herbivorous zooplankton feeding on the algae (TL =2), large zooplankton or small fishes feeding on the herbivorous zooplankton (TL=3) and large fishes like cod, tuna and groupers whose food tends to be a mixture of low and high TL organism (TL=3.5-4.5). The mean TL of landings can be used as an index of sustainability in exploited marine ecosystems. Fisheries tend to remove large slower growing fishes and thus reduce the mean TL of the fish remaining in the ecosystem. This eventually lead to declining trends of mean TL in the catches extracted from that ecosystem, a process now known as fishing down marine food web. Fisheries tend to reduce the size of the fish in an exploited stock, they also reduce their TL.

Vivekanandan and others from CMFRI considered the annual mean trophic level (TrL) of marine fish landings along the Indian coast consisting of 53 exploited species/groups was estimated for the period 1950–2002. They found that the landings as well as TrL increased along the northwest (NW) and southwest (SW) coasts. However, increase in the landings was associated with decrease in mean TrL along the east coast, particularly along the southeast (SE) coast at the rate of 0.04 per decade. The increasing trend of the FIB (Fishery in balance) index ceased in the last 5–10 years along three coasts. The landings of most of the large predators increased along the Indian coast, but higher removals appear to have helped proliferation of their prey, the mid-level carnivores. Fishing the food web has been influenced by environmental fluctuations, advanced fishing technologies, and market-driven, deliberate fishing on low-trophic level (TL) invertebrates such as the penaeid prawns.

Adapted from: Pauly et al. Towards sustainability in world fisheries, *Nature* 418: 689-695 and Vivekanandan, et al. Fishing the marine food web along the Indian coast. *Fisheries Research* 72: 241–252

4.5 Coral Reefs

Coral reefs are aragonite structures produced by living organisms, found in marine waters with little to no nutrients in the water. High nutrient levels such as those found in runoff from agricultural areas can harm the reef by encouraging the growth of algae. In most reefs, the predominant organisms are stony corals, colonial cnidarians that secrete an exoskeleton of calcium carbonate. The accumulation of skeletal material, broken and piled up by wave action and bioeroders, produces a massive calcareous formation that supports the living corals and a great variety of other animal and plant life.

Although corals are found both in temperate and tropical waters, shallow-water reefs are formed only in a zone between latitudes 30°N to 30°S of the equator. Tropical corals do not grow at depths of over 50 m (165 ft). Temperature has less of an effect on the distribution of tropical coral, but it is generally accepted that they do not exist in waters below 18 °C. and that the optimum temperature is 26-27 °C for most coral reefs. The reefs in the Persian Gulf however have corals adapted to changing temperatures of 13 °C in winter and 38 °C in summer, thus having significantly colder and hotter ambient environments respectively than most coral reefs. Deep water corals are more exceptional as they can

survive in deeper and cooler waters and also form reefs; though very little is known about them.

The great barrier reef off the coast of Queensland, Australia

Often called the 'rainforests of the sea', coral reefs are home to a spectacular variety of organisms. Calcareous algae (stony seaweeds), mollusks, echinoderms, and protozoans also contribute to the reef. Different organisms have different reef-building roles. Some, especially the corals, provide the main structural framework of the growing reef, although in parts of the world such as the central Pacific, where the surf is very strong, calcareous algae may be more important in the roughest places. Almost all shelly and calcareous organisms and those with spicules, such as sponges and sea cucumbers, provide fragments that wash or fall into the gaps between corals. Other organisms, especially algae and protozoans, bind and cement everything together with sheetlike growth.

Coral reefs take four principal forms. Fringing reefs consist of a flat reef area directly skirting a nonreef island, often volcanic, or a mainland mass. Barrier reefs are also close to a nonreef landmass but lie several kilometres offshore, separated from the landmass by a lagoon or channel often about 50 metres (160 feet) deep. Some barrier reefs are more or less circular, surrounding an island, but larger barrier reefs, such as those along the Red Sea coast and the Great Barrier Reef of Australia, are complex linear features consisting of chains of reef patches, some of them elongated into ribbon reefs. The third category of reefs is atolls, which are like circular barrier reefs but without their central landmass. Finally, there are patch reefs, which have irregular tablelike or pinnacle features. Smaller patches occur inside atoll lagoons. Larger patches occur as isolated parts of larger developments of any of the other three reef categories. They sometimes occur completely separate from other kinds of reefs.

Worldwide, coral reefs are estimated to cover 284,300 square kilometres, with the Indo-Pacific region (including the Red Sea, Indian Ocean, Southeast Asia and the Pacific) accounting for 91.9% of the total. Southeast Asia accounts for 32.3% while the Pacific including Australia accounts for 40.8%. Atlantic and Caribbean coral reefs only account for about 7.6% of the world total.

Location of coral reefs in the world

Coral reefs are either restricted or absent from the west coast of the Americas, as well as the west coast of Africa. This is primarily due to upwelling and presence of strong cold coastal currents that reduce water temperatures in these areas. Corals are also restricted from off the coastline of South Asia from Pakistan to Bangladesh. They are also restricted along the coast around north-eastern South America and Bangladesh due to the release of vast quantities of freshwater from the Amazon and Ganges Rivers respectively.

Threats to Coral reefs

Human activity may represent the greatest threat to coral reefs. In particular, global warming, coral mining, pollution (organic and non-organic/chemical), over-fishing, and the dredging of canals and access ways into islands and bays are the most serious threats to these ecosystems. Of the 845 species of reef building corals, about 27 percent are threatened, 20 percent are nearly threatened and data is deficient for 17 percent to determine the status.

Global warming

Global warming introduces sea level rise, effectively asking the coral to grow faster to keep up. Also increasing sea temperature is very disturbing to the coral resulting in coral bleaching. This was observed during the 1998 and 2004 El Niño weather phenomena, during which sea surface temperatures rose well above normal and many tropical coral reefs were bleached or killed. Some recovery has been noted in more remote locations, but global warming could negate some of this recovery in the future. Corals provide protective housing for symbiotic algae called zooxanthellae, which in turn provide the characteristic pigmentation and about 95% of the energy to the coral host. High seas surface temperature coupled with high light intensity triggers the death of zooxanthellae, and its loss of pigmentation in corals causing coral bleaching. A related problem to global warming is ocean acidification, which is caused by increasing carbon dioxide in the atmosphere and sea water.

Pollution

Runoff from farming, construction of roads, buildings, ports, channels, and harbors, carry sediment laden with carbon, nitrogen, phosphorus, and minerals. This nutrient-rich water can cause algal blooms, which have the potential to create hypoxic conditions by using up all available oxygen. Untreated urban sewage also causes eutrophication in coastal waters. Sometimes windborne sediment blown in certain regions also causes damage to coral reefs. Effluents discharge from industrial manufacturing (of chemicals, fertilizers etc), oil spill, radioactive waste may also caused pollution.

Mangroves and seagrass beds

Wetlands, mangroves and seagrass beds absorb massive amounts of nutrients ans sediments, helping to maintain the coastal waters clean. Within the last 20 years the once prolific seagrass beds and mangrove forests have been destroyed. Both the loss of wetlands, mangrove habitats and seagrass beds are considered to be significant factors affecting water quality on inshore reefs.

Coral mining and physical destruction

Small scale coral mining by coastal population as well as large-scale mining conducted by companies is another type of threat to coral reefs. Mining is often done for construction purposes, and is of particular value as these lime rocks can be up to 50 % cheaper than that form other terrestrial quarries. Dynamite fishing practiced in some places is very destructive to corals. Occasional grounding and mooring of fishing boats and other large vessels can also causes considerable damage to coral reefs.

Adapted from: http://www.panda.org/about_wwf/what_we_do/marine/blue_planet/coasts/coral_reefs/coral_threats/, http://www.coral.org/resources/about_coral_reefs threats_to_coral_reefs, http://oceanservice.noaa.gov/education/kits/corals coral09_humanthreats.html (Accessed 05 January 09)

Answers to OIP Quiz.

1. b) *32* is the correct answer.

   The world's oceans are home to some 210000 known species. Of the 33 animal phyla that exist worldwide, 32 occur in the sea, 15 are exclusively marine and five are nearly so. Only 1 phylum occurs exclusively on land.

2. b) *25 percent* is the correct answer.

   More than a quarter of marine fish species inhabit coral reefs, using these structures as critical source of shelter and food. In total, as many as 100000 reef species have been named and described, though estimates range as high as 1 to 3 million.

3. c) *30 million* is the correct answer.

   Most of the estimated 30 million small-scale fishers in the tropics and sub-tropics depend to some extent on coral reefs for their livelihoods and daily sustenance, harvesting fish, mussels, crustaceans, sea cucumbers, sea weed or other products. If corals are destroyed by rising sea temperatures, loss of the reefs would affect not just diverse species that exist within coral reef ecosystems worldwide but also millions of fishermen depending on the re-sources.

4. b) *Pollution stresses* is the correct answer.

   The greatest threats to reefs are over fishing and pollution from poor land management practices. In a study in Indonesia, reefs subject to pollution stresses showed a 30 to 60 percent reduction in species diversity.

5. a) 80 percent is the correct answer.

   An estimated 80 percent of marine debris is from land-based sources and the rest coming from marine activities. The sources fall into four major groups: tourism related litter, sewage-related debris, fishing-related debris,

and waste from ships and boats. Marine debris is a cause of injury and death to numerous marine animals and birds, either because they become entangled in it or because they mistake it for prey and eat it.

6. c) *50 percent* is the correct answer.

   Over the past 200 years, the oceans have absorbed about half of human-caused CO_2 emissions, lowering the pH of the oceans by about 0.1. This increasing acidity threatens marine life that builds shells and skeletal structure out of calcium carbonate-including corals and echinoderms (starfish, sea urchins etc) as well as certain crustaceans, molluscs and planktonic organisms.

7. a) *Feeds for aquaculture* is the correct answer.

   Currently more than a third of the fish used to make fishmeal goes into producing feeds for aquaculture (fish farming). Some intensive forms of aquaculture can be harmful to wild fish populations. For example, fish farming that focuses on large, carnivorous species like salmon and tuna consumes many times more wild fish in the form of feed than it yields farmed fish for human consumption.

8. b) *Longline fishing* is the correct answer.

   Primary threats of aquaculture to marine ecosystems include depletion of wild stocks for feed or seed, habitat loss, effluent discharge, chemical contamination, escape of non-native species and introduction of diseases. Longline fishing is the practice of stringing lines of baited hooks across the ocean to catch mainly tuna and swordfish, which often results in the accidental hooking of sea birds, turtles and other species.

9. d) All the above is the correct answer.

   Mangroves support many valuable fisheries species, including an estimated 80 percent of all marine species of commercial or recreational value in Florida. Large scale mangrove destruction is a relatively recent phenomenon, as forests are converted for aquaculture, industrial forestry and agricultural, industrial and tourist facilities. Recent massive losses of mangrove forests have resulted in the release of large quantities of stored carbon, contributing to human induced climate change.

10. a) 1 percent is the correct answer.

    Despite the urgent need to create a global network of marine reserves, it has taken some 30 years to achieve the current level of ocean protection of roughly 1 percent (compared with more than 12 percent on land) Of this only about 0.1 percent is fully protected, and many critical ocean ecosystems, including coral reefs seamounts and hydrothermal vents, remain vulnerable.

Adapted from: http://www.worldwatch.org/node/5358 (accessed on 08-01-2009)

4.6. STRANGE…..BUT TRUE

From the seashore to its unfathomable depths, the ocean is home for diverse life forms. There are big animals and little ones, long and short ones, multicolored and drab ones, and those that just sit while others that never stop moving. There are some organisms that can light up and some produce electricity. There are wonderful relationships, unique bonds and strange life histories. Given below are few of these interesting facts on marine life.

Dolphins

Man had always assumed that he was more intelligent than dolphins because he had achieved so much… The wheel, the New York, wars and so on, whilst all the dolphins have ever done was muck about in water having a good time. But conversely the dolphins believed themselves to be more intelligent than man for precisely the same reason.

- Douglass Adams

The lasting mother-calf bond

Like most mammals, dolphins give birth to their offspring through the birth canal in the female abdomen. The gestation period ranges from 9.5 to 17 months. Usually there is only a single offspring, delivered either tail or head first. Either a male or a female "auntie" dolphin may assist with the birth and are generally the only other dolphin allowed near the calf. Dolphins have a relatively close relationship with their offspring with a long period of parental care through maturation.

When a new baby dolphin is born it immediately heads for the surface of the water with the help of its mother for its first breath. It is nursed at the surface of water as the mother turns on her side to allow the calf to breathe easily while nursing. Generally nursing lasts up to 18 months. The milk containing about 33% fat helps the calf develop a thick layer of blubber for insulation. The rapid growth of a baby dolphin is largely due to the nutritious milk of its mother with rich fat, protein, calcium and phosphorus content. The calves start to take a few fish at about 90 to 120 days. Mother-calf bonds are strong and long-lasting with calves staying with their mother 3 to 6 years or more. An average bottlenose dolphin calf is a little over 3 feet at birth and can grow to eight or nine feet long.

Did you know that dolphins are so intelligent that within only a few weeks of captivity, they can train humans to stand at the edge of the pool and throw them fish?

Watch that sound!

Bottlenose dolphins identify themselves with a signature whistle. However, scientists have found no evidence of a dolphin language. Apart from whistle, bottlenose dolphins produce clicks and sounds that resemble moans, trills, grunts, squeaks, and creaking doors. They make these sounds at any time and at considerable depths. These sounds vary in volume, wavelength, frequency, and pattern. A mother dolphin may whistle to her calf almost continuously for several days after giving birth. This acoustic imprinting helps the calf to identify its mother.

Sounds are probably produced by movements of air in the trachea and nasal sacs. During some vocalizations, bottlenose dolphins actually release air from

the blowhole. But scientists believe that these bubble trails and clouds are a visual display and not necessary for producing sound.

Although dolphins have large eyes located near the corners of their mouths with acute vision both in and out of the water, a great deal of their finding of food is done through echolocation. The term echolocation refers to an ability of some animals (dolphins and bats) essentially to "see" with their ears by listening for echoes. Dolphins echolocate by producing clicking sounds and then receiving and interpreting the resulting echo. Dolphins produce directional clicks in trains, each click lasting less than a second.

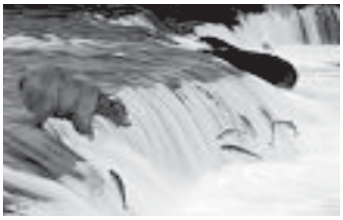
Social behavior

Dolphins live in groups called pods which are coherent, long-term social units that vary in size, structure and composition depending on age, sex and reproductive condition. Many pods are composed of mother-calf pairs or of mature females and their recent offspring while others occur in mixed-sex and single sex groups. Some adult males are observed to be alone, in pairs or occasional trios, moving between female groups in their age range, pairing up with females for brief periods.

Adult males rarely associate with sub-adult males. Does this sound familiar? At times several pods may join for short periods to form herds or aggregations of up to several hundred animals. Whatever the size of the group, social hierarchy may often be observed in bottlenose dolphins.

Adapted from: http://www.cabodolphins.com/site-map.htm (Accessed on 28 December, 2008)

Animal Migration - Defying Distance



Animals undertakes extensive seasonal migrations for breeding, feeding and evading adverse conditions. Many types of birds and fish migrate on a regular basis, on time scales ranging from daily to annual, and over distances ranging from a few meters to thousands of kilometers.

Fish usually migrate for feeding and breeding, and in some cases for unknown reasons. There are some species which seasonally move from sea to inland rivers (anadromous) and others who move from rivers to the sea (catadromous) for breeding. Some fish shuttle within the rivers (Potamodromous) and some others move within salt water only (Oceanodromous).

Adult salmons live in the sea and migrates to inland rivers for breeding. Salmon are capable of going hundreds of kilometers upriver, and fish ladders are installed in dams to enable the salmon to get past. Only about 15 percent of the spawned adults return to sea, the rest end their life in the river. The salmon hatch in small freshwater streams and the hatchlings migrate to the sea to mature and live there for two to six years. When mature, the salmon return to spawn to very the same streams which they left as hatchlings years before.

The freshwater eels of genus *Anguilla*, also make remarkable migrations. Adults American eel (*Anguilla rostrata*) of age five to 20 years migrate to the Sargasso Sea in the Atlantic to spawn and end their life there. Their larvae drift with the Gulf stream current to reach their native freshwater bodies. In some cases, the young ones may take several months or years, travelling thousands of kilometres before reaching their native streams.

Bull shark, live in freshwater, yet they also migrate to and from the ocean. Bull sharks of Lake Nicaragua migrate to the Atlantic Ocean while those of Zambezi migrate to the Indian Ocean.

Diel vertical migration is a commony observed in many marine species. They generally move to the surface at night and then return to the depths during daytime. Food, light, temperature and predators are important factors influencing the the diel migration.

The term 'highly migratory species' (HMS) has its origins in Article 64 of the United Nations Convention on the Law of the Sea. These are species which undertake migrations of significant but variable distances across oceans for feeding or reproduction. Geographic distributions of these species overlap the open seas and the EEZs of several nations and therfore require international collaboration in their management. Tuna and tuna-like species, shark, marlin and swordfish are the common HMS.

Adapted from: http://en.wikipedia.org/wiki/Fishery (Accessed on 26 December, 2008)

The Circum-navigator

The Arctic tern (*Sterna Paradisaea*) is a seasoned traveller. It breeds in the northern hemisphere, mostly within the Arctic Circle, but flies to spend the northern winter in the southern hemisphere, mostly in the Antarctic ice-packs. The round-trip journey between Arctic and Antarctic is 35,000 km (21,750 miles) - roughly equal to the the circumference of the Earth. Considering that some of these birds live 30 years or more, they would have loged over 1 million km (over 650,000 miles) flight in their lifetime! For a bird that is 38 cm long and weigh 300 g, this is no mean achievement. This journey is not whithout benefits, the trip to the Antarctic enables the arctic tern to enjoy the benefits of a 2nd summer, making the most of daylight and a plentiful supply of food.

Arctic Terns breed in colonies numbering hundreds or sometimes thousands of pairs. The breeding colonies are generally very noisy, but just before migration all the birds suddenly go completely quiet and then fly up together out to the sea. This odd behaviour is known as 'dread', but the reason for it is not understood.

Adapted from : http://www.panda.org/news_facts/education/middle_school/species/(Accessed on 2 January, 2009)

Penguins - The Signature Species

When one thinks of Antarctic wildlife, penguins are often the first animals that come to mind. Penguins are considered by many as the 'signature species' of the polar south. As sea birds, they are superbly designed for swimming underwater with great skill, speeding up to 25 miles per hour. Early Antarctic explorers thought penguins as fish and classified them accordingly. When traveling at speed, penguins take quick leap clear of the water every few feet, an action called 'porpoising', which enables them to breathe and also evade a predator.

Penguins are also found as far north as the Galapagos Islands, straddling the Equator. Penguins are true flightless birds. Some species spend as much as 75% of their lives at sea, yet they all breed on land or sea-ice attached to land.

Some species can dive to depths exceeding 1000 feet and stay submerged for about 25 minutes, though most prefer shorter, shallower dives.

Never be late with date

In most species of Penguins, the males arrive at the breeding site a few days before the females, and this is due to the fact that there are more males than females. Popular belief is that most penguins are not faithful for life, and the rules of partnership are complex.

Both partners generally return to the same breeding site each year, and many species use the same nest, which they refurbish each season. The male usually seeks out his previous partner in order to mate with her once more, but if the female arrives at the nest site first, and cannot find her previous mate, she will quickly pair with any unattached male nearby.

This makes sense, since if she waits too long for a mate who fails to arrive, she will loose her opportunity to breed that season. On the other hand, it is in the interest of the male to arrive at breeding site well before the female, since it is much harder for an unpaired male to find a replacement female. On occasions if a female arrives at the nest site first and does not find her previous partner, she will proceed to mate with another male, only to reform her partnership with the previous partner when he finally appears. This leaves her unsuspecting old partner to incubate the egg fertilised by another male and rear the offspring as his own.

Penguins generally breed in large, dense colonies called 'rookeries', some with 180,000 or more birds. Most penguins build nests of stones and pebbles and lay one or two eggs. Adult pairs take turns incubating their eggs and feeding the chicks once they hatch out. In addition to vocal signals, penguins also communicate by head and flipper waving, bowing, gesturing and preening.

Begging Chicks

Penguin chicks must beg for food in order to initiate a feeding response from the parent, and this is usually done by constant pecking around the parents bill. Penguins, unlike most other birds, do not have crops and regurgitate partially digested food directly from the stomach. Generally it is the adults who must ensure that the feeding demands from their own chick, since hungry chicks will happily beg from any passing adult, or even other chicks.

Adapted from : http://www.antarcticconnection.com/antarctic/wildlife/index.shtml; http://www.penguins.cl/index.htm (Accessed 2 January, 2009)

Timid Sea Lions

California sea lions are found along the west coast of North America from Vancouver to northern Mexico. Sea lions gather in huge herds to mate and one bull may mate with more than one cow. A dominant bull is known as the beach master and may have harem of up to 50 females!

Males and females of sea lion differ in size. A male Steller's sea lion, for example, can reach 2.8 m in length and weigh up to 570 kg while the female is about 2.2

m long and a third the weight of the male. Sea lions get their name from their thick lion-like mane and their call which sounds like the roar of a lion. Despite their formidable look and sound, they are actually very timid, except when defending their pups.

Adapted from : http://www.panda.org/news_facts/education/middle_school/species/ (Accessed 2 January, 2009)

Seals - the best divers

Seals have a slick, streamlined, torpedo-shaped body which makes them among the world's best divers. The seals have their 4 limbs modified into flippers that give them the scientific name, pinnipedia, or 'fin-footed animals'. Some seals are able to dive to depths more than 150-250 metres and can remain under water for 20 minutes.

The smallest seal is the ringed seal of the Arctic, which is about 1.5 metres long and weighs up to 90 kg. The largest earless seal is the southern elephant seal, which weighs over 3,000 kg and can attain a length of 6 m.

A male (bull) grey seal will establish a territory in the breeding colony and in the sea nearby. Up to 70,000 grey seals can gather together in a single breeding colony! Grey seals give birth to their young in the autumn or winter. A bull mates with several females (cows) soon after they have given birth. Mating happens in the sea or on land. It takes 10 months to 1 year before the new pups are born.

Seals have long association with human civilization. One of the first coins, minted around 500 BC, depicted the head of a monk seal, and the creatures were immortalized in the writings of Homer, Plutarch and Aristotle.

Adapted from: http://www.panda.org/news_facts/education/middle_school/species/ (Accessed 1 January, 2009)

Tusks and Moustache

Walruses live mainly in shallow coastal waters in the Arctic region. They are found off Alaska, northern Canada, the Chukchi Sea in Russia, and western Greenland. Each year they migrate, following the ice south in winter and north in summer. The walrus has peculiar features like a pair of long, curved tusks and bristly, drooping hair on its upper lip which gave rise to the term 'walrus moustache'. The tusks are elongated upper canine teeth which serves to stir up food from the sea bed, to fight other males, and to help clamber up onto ice. Males display and spar with their tusks for a favoured position at the breeding site. Older males bear many scars from these battles!

Adapted from : http://www.panda.org/news_facts/education/middle_school/species/(Accessed 2 January, 2009)

Half asleep like a Whale!

All mammals including whales sleep. Because they are air breathing animals living in water, unlike other animals, whales are conscious breathers - they decide when to breathe. Since they need to be conscious in order to breathe, whales cannot afford to fall into an unconscious sleep for too long. It is thought that only one hemisphere of their brains sleeps at a time, so that whales are never completely asleep, but still get the rest they need. This is because whales often sleep with only one eye closed.

Adapted from: http://en.wikipedia.org/wiki/Category:Cetaceans (Accessed 27 December, 2008)

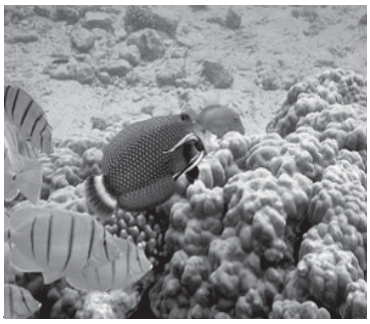
A Whalesome Life!

The Blue Whale is the largest known mammal that has ever lived, and is the largest living animal, measuring about 35 m (105ft) long and weighing nearly 150 tons. Whales generally live for 40-90 year depending on the species, and on rare occasions some may live over a century. Recently a fragment of a lance used by commercial whalers in the 19th century has been found in a bowhead whale caught off Alaska, which showed the whale to be between 115 and 130 years old. A technique of age determination from aspartic acid racemization in the whale eye, combined with dating of a harpoon fragment, indicated the age of one male bowhead whale 211 years!

Adapted from: http://en.wikipedia.org/wiki/Category:Cetaceans (Accessed 2 January, 2009)

Get Cleaned for Free

Cleaner shrimp is a generic term for any swimming decapod crustacean that cleans other organisms of parasites. This is a widely-cited example of symbiosis - a relationship in which both parties benefit. The fish benefit by having parasites removed from them, and the shrimp enjoys its meal on the parasites. Cleaner shrimp may belong to any of three families, Palaemonidae (including the spotted cleaner shrimp, *Periclimenes yucatanicus*), Hippolytidae (including the Pacific cleaner shrimp, *Lysmata amboinensis*) and Stenopodidae (including the banded coral shrimp, *Stenopus hispidus*) . The last of these families is more closely related to lobsters and crabs. Cleaner shrimp are often included in salt water aquaria to keep the tank clean.



A dragon wrasse *Novaculichthys taeniourus* being cleaned by Rainbow cleaner wrasses, *Labroides phthirophagus* on a reef in Hawaii.

In some coral reefs, cleaner organisms as well as 'dirty and infested' fish and other marine orgnisms congregate at a common business centre called 'cleaning station'. Cleaning stations are often associated with coral features, located either on top of a coral head or in a slot between two outcroppings.

The cleaning process includes the removal of parasites from the animal's body surface as well as mouth and gills. Cleaning is performed by various creatures including cleaner shrimp and numerous species of cleaner fish, especially wrasses and gobies.

When a fish approaches a cleaning station it will pose in an 'unnatural' way to show the cleaner fish that they want to be cleaned and pose no threat. This message is conveyed by pointing in a strange direction and/or opening the mouth wide. The cleaner fish will then eat the parasites directly from the skin of the

cleaned fish. It will even swim into the mouth and gills of the fish to be cleaned and pick up all nasty things with relish.

Adapted from: http://en.wikipedia.org/wiki/Category:Decapods (Accessed 2 January, 2009); http://en.wikipedia.org/wiki/Category:Marine_biology (Accessed 4 January, 2009)

Clowns - Serious Friends

In the marine a aquarium you invariably find clownfishes swaying amoung the sea anemones which are called sea lotuses. Clownfish and anemonefish are fishes strongly bonded in a symbiotic relationships with sea anemones. Clownfish are generally host specific. The clownfish feed on undigested matter which otherwise potentially could harm the sea anemone, and the faecal matter from the clownfish provides nutrient to the sea anemone. It has also been suggested that the active movement of the clownfish results in greater water circulation around the sea anemone. In addition to providing food for the clownfish, the sea anemone also provides protection from predators. Clownfish and certain damselfish can avoid the potent poison of a sea anemone.

When Dad Becomes Mom

Clownfish live in small groups inhabiting a single anemone. The group consist of a breeding pair, which cohabit with a few non-reproductive, "pre-pubescent" smaller male clownfish. When the female of the breeding pair dies, the dominant male changes sex and becomes the female. This strategy is known as sequential hermaphroditism. Because clownfish are all born as males, they are protandrous hermaphrodites (*pro*=first; *androus*=male). This is in contrast with another form of hermaphroditism, known as protogyny, in which all fish are born as females but can change to males later.

Adapted from: http://en.wikipedia.org/wiki/Category:Symbiosis (Accessed 4 January, 2009)

Wings of Water

Can you imagine fishes taking short gliding flights through air, above the surface of water, in order to escape from predators? Well, a group of fish called flying fishes are capable of performing this extraordinary feat. The flying fishes of the family **Exocoetidae** comprising about 50 species are widely distributed in the warm tropical and subtropical waters of the Atlantic, Pacific, and Indian oceans. Their most striking feature is their pectoral fins, which are unusually large wing-like, enabling the fish to take short gliding flights through air, above the surface of water. In some species the pelvic fins are also unusually large, so the fish appears to have four wings. Most species reach a maximum length of 30 cm, though a few may attain 45 cm. Compared to the flightless fish, their eyes are relatively larger and flatter, which improves visual acuity in the air. Flying fish live near surface and feed on plankton. Flying fish use their unusual flying talent to escape predators such as swordfish, tunas, and other larger fish.

To prepare for a flight, the fish swim rapidly close to the surface of the water, with their fins close to the body. As they leave the water, they spread their fins and glide short distance. Flying fish can reach heights up to 1.2 meters. They

can even flap their "wings" while gliding and can almost double their speed up to 60 km per hour. The glides are usually up to 30-50 meters in length, but some have been observed soaring for hundreds of metres using the updraft on the leading edges of waves.

In May 2008, a Japanese television crew (NHK) filmed a flying fish off the coast of Yakushima Island, Japan. The creature spent 45 seconds in flight, beating the previous record was 42 seconds. This is thought to be one of the longest recorded flights by a flying fish. The fish was able to stay aloft by occasionally beating the surface of the water with its caudal fin. Historically the country of Barbados was nicknamed as *"The land of the Flying fish."*

Adapted from : http://en.wikipedia.org/wiki/Category:Exocoetidae (Accessed 4 January, 2009)

Small is Bountiful

The **gobies** form the family **Gobiidae**, which is one of the largest families of fish, with more than 2,000 species in more than 200 genera. Gobies include some of the smallest vertebrates in the world, like species of the genera *Trimmaton* and *Pandaka*, which are under 1 cm (3/8 in) long when fully grown. There are some exceptional gobies attaining over 30 cm (1 ft) length.

The most distinctive aspect of goby morphology is the fused pelvic fins that form a disc shaped sucker. Gobies can often be seen using the sucker to adhere to rocks and corals, and in aquariums they stick to glass walls of the tank as well.

Adapted from: http://en.wikipedia.org/wiki/Category:Gobiidae (Accessed 4 January, 2009)

A Goby Watch

Some marine gobies live in symbiosis with burrowing shrimps. The shrimp maintains a burrow in the sand in which both the shrimp and the goby live. The shrimp has poor eyesight compared to the goby. The goby and shrimp keep contact with each other, the shrimp using its antennae, and the goby flicking the shrimp with its tail. When alarmed by some threat the goby suddenly swim into the burrow, and the shrimp catching the stimulus will follow the fish. These gobies are thus sometimes known as 'watchmen' or 'prawn gobies'. Both the parties gains from this relationship. The shrimp gets a warning of approaching danger, and the goby gets a safe home and a place to lay the eggs.

Another example of symbiosis is demonstrated by the neon gobies (*Elacatinus* spp.). These gobies are known as "cleaner gobies", and remove parasites from the skin, fins, mouth, and gills of a wide variety of large fish.

http://en.wikipedia.org/wiki/Category:Symbiosis (Accessed 4 January, 2009)

Hunting Together

In the December 2006 issue of the journal *Public Library of Science Biology*, a team of biologists announced the discovery of interspecies cooperative hunting

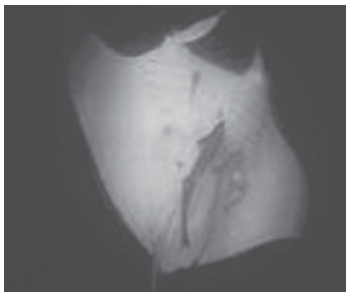
involving morays. The biologists, who were engaged in a study of Red Sea cleaner fish (fish that enter the mouths of other fish to rid them of parasites), discovered that a species of reef-associated grouper, the roving coral grouper (*Plectropomus pessuliferus*), often recruited morays to aid them while hunting for food. This is the first discovery of cooperation between fish in general.

Adapted from : http://www.livescience.com/animalworld/061207_fish_cooperation.html; http://en.wikipedia.org/wiki/Category:Muraenidae (Accessed 4 January, 2009)

Sucker on Free Ride

Remoras or suckerfish are elongate brown fish in order Perciformes and family Echeneidae. They grow up to 30 to 90 cm (1–3 ft), and their first dorsal fin takes the distinctive form of a modified oval sucker-like organ with slat-like structures that open and close to create suction to get a firm hold on the skin of larger marine animals. They also swim well on their own, with a sinuous motion.

Some remoras associate primarily with specific host species. Remoras are commonly found attached to sharks, manta rays, whales, turtles, and dugong (hence the common names sharksucker and whalesucker). Smaller remoras also fasten onto fish like tuna and swordfish, and some small remoras travel in the mouths or gills of large manta rays, ocean sunfish, swordfish, and sailfish. Remoras sometimes even attach themselves to small boats.



The relationship between remoras and their hosts is most often taken to be one of commensalism. The host they attach to for transport gains nothing from the relationship, but also loses little. The remora benefits by using the host as transport and protection and also feeds on materials dropped by the host.

Suckerfishes have been used for catching turtles as 'fishing fish'. A cord or rope is fastened to the remora's tail, and when a turtle is sighted the fish is released from the boat. The fish usually heads directly for the turtle and fastens itself to the turtle's shell. Then both the remora and turtle are hauled in using the cord. Smaller turtles can be pulled completely into the boat by this method, while larger ones are hauled within harpooning range. This practice has been reported throughout the Indian Ocean, especially from eastern Africa near Zanzibar and Mozambique, and from northern Australia near Cape York and Torres Strait.

Adapted from: http://en.wikipedia.org/wiki/Category:Echeneidae (Accessed 4 January, 2009); *E. W. Gudger (1919).* "On the Use of the Sucking-Fish for Catching Fish and Turtles: Studies in *Echeneis* or *Remora*, II., Part 1.*". The American Naturalist* ***53*** *(627): 289–311.;* http://en.wikipedia.org/wiki/Category:Echeneidae(Accessed 2 January, 2009)

Pregnant Papa…Jolly Mamma

When it comes to sharing the burden of raising the progenies, Seahorses are the role models for the entire animal kingdom. When a male and female seahorse discover a mutual interest at the beginning of breeding season, they court for several days, even while others try to interfere. During this time they change color, swim side by side holding tails or grip the same strand of sea grass with their tails and wheel around in unison in what is known as their "pre-dawn dance".

They eventually engage in their "true courtship dance" lasting about 8 hours, during which the male pumps water through the egg pouch on his trunk which expands and cleaves open to display an appealing emptiness. When the female's eggs reach maturity, she and her mate let go of any anchors and snout-to-snout, drift upward out of the seagrass, often spiraling as they rise. The female inserts her ovipositor into the male's brood pouch, where she deposits her eggs. As the female squirts anywhere from dozens to thousands of eggs from a chamber in her trunk into his pouch, her body slims while his swells. Both seahorses then sink back to the bottom and she swims off. New research indicates the male releases sperm into the surrounding sea water during fertilization, and not directly into the pouch as was previously thought.

The fertilized eggs then embed in the pouch wall and become enveloped with tissues. In most seahorse species' pregnancies lasts approximately two to three weeks. Throughout the male's incubation, his mate visits him daily for 'morning greetings'. The female seahorse swims over for about 6 minutes of interaction reminiscent of courtship. They change color, wheel around sea grass fronds, and finally promenade, holding each other's tails. Then, the female swims away until the next morning, and the male goes back to vacuuming up food through his snout.

Adapted from: http://en.wikipedia.org/wiki/Category:Hippocampus (Accessed 2 January, 2009)

Fish Out of Water

Walking fish sometimes called ambulatory fish, is a general term that refers to fish that are able to travel over land for extended periods of time. The term may also be used for some other cases of nonstandard locomotion of fish, e.g., when describing fish "walking" along the sea floor

The mudskippers are probably the best land-adapted of contemporary fish and are able to spend days moving about out of water and can even climb mangroves, although to only modest height. The Climbing gourami is often specifically referred to as a "walking fish", although it does not actually "walk", but rather moves in a jerky way by supporting itself on the extended edges Some reports indicate that it can also climb trees.

There are a number of fish that are less adept at actual walking, such as the walking catfish. Despite being known for "walking on land", this fish usually wriggles and may use its pectoral fins to aid in its movement. Walking Catfish have a respiratory system that allows them to live out of water for several days. Some are invasive species. A notorious case in the United States is the Northern snakehead. Polypterids have rudimentary lungs and can also move about on land, though rather clumsily.

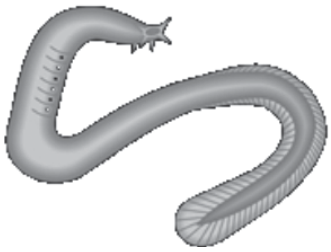
There are some species of fish that can "walk" along the sea floor but not on land. One such animal is the flying gurnard, which can walk on the sea floor. (It does not actually fly, and should not be confused with flying fish.) The batfishes of the Ogcocephalidae family (not to be confused with Batfish of Ephippidae) are also capable of walking along the sea floor.

Adapted from: http://en.wikipedia.org/wiki/Walking_fish (Accessed on 2 Janaury 2009)

4.7 Strange and Weird from Deep sea

The deeper zones of the ocean are home for some peculiar organisms. Species inhabiting this zone need special adaptations to survive in this dark, oxygen poor and cold and denser waters. Given below are 10 different animals which are unique.

The hagfish (Slime Eel)



The Atlantic Hagfish is otherwise known as the nastiest little creature of the deep sea. Scientifically known as *Myxine glutinosa*, hagfish is a true monster of the deep water, found worldwide at depths of 5600 feet. They live on soft bottoms where they lie buried except for the top of their head.

What really makes the hagfish a monster is its feeding habit. The hagfish attaches itself to a passing fish and then bores its way inside its unsuspecting host. Once inside, the hagfish will actually eat the fish's flesh with a specialized rasping tongue. It literally eats its victim from the inside out. How's that for a monster?

Hagfish are almost blind, with poorly developed eyes located just beneath the skin. The long, scaleless, soft-skinned, eel-like body ranges in size from 16 to 32 inches. The hagfish have barbels on the end of their mouth and have no jaws or bones.

Adapted from: http://www.seasky.org/deep-sea/creatures-menu.html (Accessed 27, December, 2008)

The Coelacanth (The living fossil)

The strange-looking coelacanth (*Latimeria chalumnae*) is one of the oldest species of fish in the world, thought to have been extinct over 65 million years ago. Fossils records of coelacanth date back over 350 million years.

In 1938, a fisherman caught a live coelacanth off the coast of South Africa. A second specimen was captured in 1952 near Madagascar. Now coelacanths can be found throughout the Indian Ocean, from the southwest coast of Africa to Indonesia. They are found as deep as 700 meters, but are more commonly found at a depth of 90 - 200 meters. Coelacanths are large fish, growing to average length of 2 meters and can weigh up to 80 kg.

They are nicknamed "old fourlegs " since they have leg like fins. The fins of the coelacanth actually contain bones that resemble toes divided into three lobes. They have cosmoid scales, which are found only on extinct fish species. The scales are woven tight like armor and provide roughness and toughness necessary to protect the fish from rocks and predators.

The eyes of the coelacanth are extremely sensitive to light, they contain a special adaptation known as a tapetum, which is also found in cats, dogs, and dolphins. It is the tapetum that causes a cat's eyes to glow when exposed to bright light. Because of their sensitive eyes, these fish prefer the darkness. In Sodwana Bay, South Africa, coelacanths have been found resting in caves during the day. They hunt their prey near deep underwater volcanic slopes and can frequently be seen swimming with their heads down.

Coelacanths give birth to live young, known as "pups". There are usually between 5 and 25 pups born at any given time. These young coelacanth pups are fully

formed and capable of surviving on their own as soon as they are born. Their gestation time is 13 months, and it is believed that coelacanths are unable to reproduce until they are 20 years old.

In 1989, the coelacanth was declared an endangered species. Their current world population is believed to be fewer than 500 animals.

Adapted from: http://www.seasky.org/deep-sea/creatures-menu.html (Accessed 27, December, 2008)

The common black devil

The deep sea anglerfish (*Melanocetus johnsoni*), one of the most bizarre looking fish, is one of the best-known creatures of the deep. The angler gets its name from an elongated dorsal spine that supports a light-producing organ known as a photophore which produces a blue-green light similar to that of a firefly on land. The fish uses this appendage like a fishing lure to attract its prey.

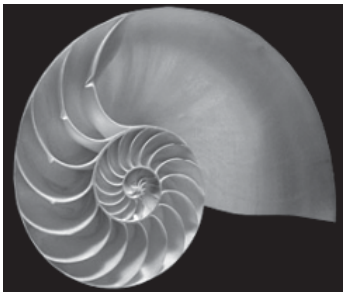
The anglers remain motionless, waving the lure back and forth like a fishing pole. When the prey fish gets close enough, the angler snaps it up with its powerful jaws and swallows it whole. The sharp teeth of the angler which are angled inwards, prevent the prey from escaping. The anglerfish can extend both its jaw and its stomach to an incredible size, allowing it to swallow a prey twice its size.

The male angler is much smaller than the female. When a male angler matures, its digestive system degenerates, making impossible for it to feed on its own. It must now find a female or die of starvation. The male angler finds a female and bites into her skin. Then he releases an enzyme that dissolves the skin of his mouth and that of her body and the two become fused together and their blood vessels join as one. The male will spend the rest of its life joined to the female like a parasite, getting all of his nourishment from her body. A female may carry up to six males on her body at a time. This bizarre method of reproduction helps to ensure that when the female is ready to spawn, she has a mate instantly available.

The deep sea angler is found throughout the world's oceans at depths of over 914 meters. Many species of anglerfish are fished commercially throughout the world. They are comparable to lobster in taste and texture. In Japan, anglerfish is considered a delicacy and can fetch a premium price.

Adapted from: http://www.seasky.org/deep-sea/creatures-menu.html (Accessed 27, December, 2008)

A species unchanged for 400 million years



Nautilus shell showing chambers

The Chambered nautilus is a mollusk and a member of the cephalopod family. It is considered as a living fossil since it has remained unchanged for over 400 million years. Of about 10,000 different species of nautilus that lived during prehistoric times, only a few are known to survive today. *Nautilus pompilius* is the largest and most common of the six species known to exist.

A siphon near the animal's tentacles expels water under pressure, propelling the nautilus in the opposite direction at high speeds. A nautilus can use jet propulsion to attain speeds of over two knots.

The life and habits of the nautilus are still largely a mystery, since it spends most of its time in deep water. The shell of the nautilus is comprised of many individual chambers. Each chamber is individually sealed and contains an amount of gas. They need to feed only once in a month since their siphon system uses very little energy while swimming.

Their eyesight is very poor because their eyes contains no lenses. Instead, there is only a tiny hole to allow light into the eye. This system operates much like a pinhole camera.

Nautiluses are found throughout the Pacific and Indian oceans, where they spend their daylight hours at deeper waters. At night they migrate to shallower waters to feed among the coral reefs. Unfortunately, nautilus populations are on the decline due to excessive exploitation for their beautiful shells. Because of this, export of the shells has been banned in many countries of the world including India.

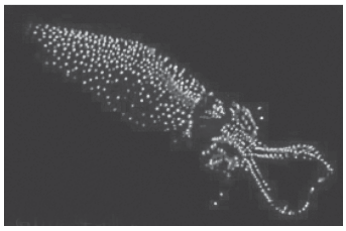
Adapted from: http://www.seasky.org/deep-sea/creatures-menu.html (Accessed 27, December, 2008)

The Firefly Squid

Of all the bioluminescent life forms in the deep sea, there is one tiny creature capable of displaying wonderful light show. This is the firefly squid (*Watasenia scintillans*), a cephalopod, sometimes called the sparkling enope squid or the "hotaru-ika". The firefly squid gets its name from the flashing lights that resemble those of a firefly. This squid is famous for the incredible light show that occurs each year off the coast of Japan as millions of these tiny animals gather to spawn.

The firefly squid grows only to seven centimeters. Thousands of tiny photophores can be found throughout the squid's body emit deep blue light along its entire form. The lights can be flashed in unison or alternated in an endless number of animated patterns. The firefly squid is the only member of the squid family that is believed to have color vision enabling them to distinguish between ambient light and bioluminescence, and to help them decode the patterns of light created by other members of the species.

Firefly squid spend their days at depths of about 1,200 feet (365 meters). At night, they migrate up to the surface to search for food before returning the darkness below.



Firefly squid with its amazing light show(Image courtesy of Danté Fenolio)

During the spawning season, the squid can be seen gathering in large numbers in Toyama Bay in Japan. They gather here by the millions, and sometimes by the billions, to lay their eggs. Once the eggs have been released into the water and fertilized, the adult squid begin to die, completing the one-year life cycle of the squid.

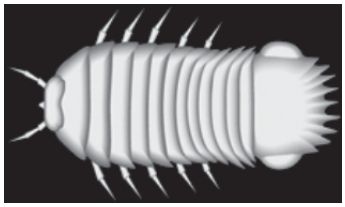
The annual light show is so spectacular that the area where they gather has been designated as a special natural monument. Toyama Bay lies above a deep, v-shaped canyon in which the sea floor drops away suddenly. The flow of the ocean currents usually wells up from the bottom of this canyon and pushes the squid to the surface. Occasionally the squid can be found washed up on the shore in large numbers during a phenomenon referred to by locals as 'squid

drowning themselves'. This event can cover the shoreline for miles, bathing the beaches in an eerie blue glow.

Firefly squid are found throughout the western Pacific Ocean at depths ranging from 600 to 1,200 feet (182 to 365 meters). This squid is a delicacy in Japan and is widely fished during spawning season. As fishing boats haul in their catches, the sea surface begins to glow a bright cobalt blue. The spectacle is so amazing that tourists travel on sight seeing boats just to watch it.

Adapted from: http://www.seasky.org/deep-sea/creatures-menu.html (Accessed 27, December, 2008)

The Giant Isopod…one of the strangest creatures of deep sea



Looking like it just crawled out of a bad science fiction movie, the giant isopod (*Bathynomus giganteus*) is without a doubt one of the strange creatures found in the deep sea.

It is also the largest (growing over 16 inches) known member of the isopod family closely related to the small pill bugs found in the garden. They are not usually fished commercially, although occasionally they are boiled and served with rice in some seaside restaurants in northern Taiwan.

The enormous size of the giant isopod is a result of a phenomenon known as 'deep sea gigantism'. This is the tendency of deep sea crustaceans and other animals to grow to a much larger size than similar species in shallower waters. Other examples of this would be the giant squid and the giant tube worm.

Giant isopod specimen - front view

The body of giant isopod is protected by a hard shell that is divided into segments making it strong and flexible. When threatened, this animal can roll itself into a ball to protect its vulnerable underside.

The isopod can go for long periods of time without eating and has been known to survive over eight weeks without food in when kept in captivity.

Giant isopods reproduce by laying eggs. The females develop a pouch known as a marsupium, where the eggs are stored until the young are ready to emerge. The young isopods, known as manca escape from the marsupium as fully formed miniatures of the adults. Bypassing the larval stages greatly enhances the young isopod's chances of survival.

Giant isopods are found in most oceans of the world. Their habitat ranges in depth from the dimly lit sublittoral zone at 550 ft (170 m) to the pitch darkness of the bathypelagic zone at 7,020 ft (2,140 m). They prefer muddy or clayey ocean bottom where they prefer to live solitary lives.

Adapted from: http://www.seasky.org/deep-sea/creatures-menu.html (Accessed 27, December, 2008)

The Enigmatic Giant Squid

The elusive giant squid (*Architeuthis dux)*, is one of the world's largest animals, reaching a length of up to 60 feet. It is the largest known invertebrate in the world and one of the largest creatures in the sea. It is believed that the 'Kraken' of ancient myth may have been based at least in part on this real life creature.

Very little is known about this mysterious creature because until recently, no one has seen it alive in the wild. Most of what we know about giant squid

comes from the bodies of dead squid washed ashore or occasionally pulled up in fishermen's nets.

A breakthrough occurred in 2004 when researchers from Japan managed to photograph a live squid in the wild. In 2006 another Japanese team was able to obtain the first ever video footage of a live giant squid. They now believe these creatures may be much more plentiful than previously thought.

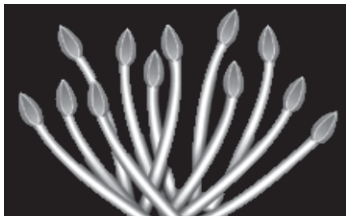
Many researchers believe the giant squid to be a very aggressive. During World War II, stories from the survivors of sunken ships tell of shipmates being eaten by these creatures in the dark of night. There have even been reports of giant squid reaching out of the water and pulling men off small boats. Though none of these reports have been officially verified, they do paint a picture of a powerful predator.

The giant squid appears to be a favorite food for the sperm whale. The squid are commonly found in the stomach contents of dead whales. Many of these whales even bear scars from the squid's suction-cupped tentacles. As for the squid, they are carnivores and may eat just about anything they can catch.

Adapted from: http://www.seasky.org/deep-sea/creatures-menu.html (Accessed 27, December, 2008)

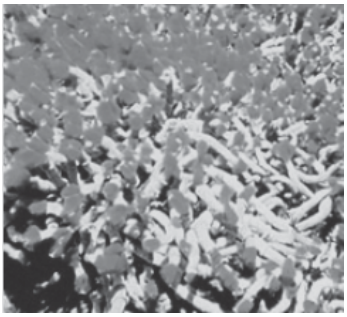
Living in hot water

The giant tube worm (*Riftia pachyptila)* was totally unknown to science until researchers exploring the deep Pacific Ocean floor discovered strange, deep sea hydrothermal vents. Powered by volcanic heat, these vents recirculate water that seeps down through cracks or faults in the rock. These hydrothermal vents are known as "black smokers" because of the dark color of the material they eject.



Giant tube worms have been found throughout the Pacific Ocean where deep sea hydrothermal vents have been discovered. The average depth of these vents is 5,000 feet (1,500 meters). These worms grow up to eight feet (over two meters) in length and have no mouth and no digestive tract. In spite of the near boiling temperature of the water, these animals were thriving in the complete absence of light. The organisms feed on tiny bacteria that get their energy directly from the chemicals in the water through a process known as chemosynthesis.

Perhaps the most noticeable characteristic of these worms is their bright red plume which is a specialized organ for exchanging compounds such as oxygen, carbon dioxide, and hydrogen sulphide with the seawater. The bright red color comes from the presence of large amounts of hemoglobin (blood).



Colony of giant tube worms (NOAA Ocean Explorer)

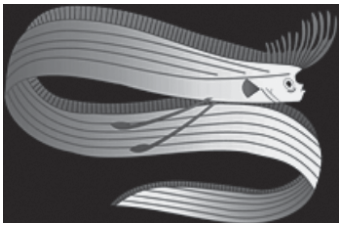
These amazing vent ecosystems are extremely fragile. As the Earth's crust shifts due to geothermal activity, the supply of chemicals through the vents can be cut off. When this happens, all the incredible creatures that depend on these chemicals will wither and die. Scientists have returned to once thriving vent sites only to find them completely cold and dead. But new ecosystems establish when a new hydrothermal vent develops elsewhere on the deep sea floor.

Adapted from: http://www.seasky.org/deep-sea/creatures-menu.html (Accessed 27, December, 2008)

Open Your Mouth …….Ah!!!!

The gulper eel (*Eurypharynx pelecanoides*) is one of the most bizarre looking creatures in the deep ocean. Its most notable attribute is the large mouth due to which it got another name, the umbrella mouth gulper. The eel's jaw is loosely hinged, and the mouth can be opened wide enough to swallow an animal much larger than itself. Any hapless fish entering its mouth is deposited into a pouch-like lower jaw, which resembles that of a pelican (so sometimes called pelican eel). The gulper's stomach can also stretch to accommodate its large meals. The eel also has a very long, whip-like tail. Specimens that have been brought to the surface in fishing nets have been known to have their long tails tied into several knots. The gulper eel grows to a length of about two to six feet and is found in all of the world's oceans at depths ranging from 3000 to 6000 feet.

Adapted from: http://www.seasky.org/deep-sea/creatures-menu.html



The longest bonyfish

The strange-looking oarfish (*Regalecus glesne*), also commonly referred to as the king of herrings, is the longest bony fish in the sea. Even though it is a deep water species, it is not too uncommon to see an oarfish.

These unusual creatures have been washed ashore on beaches after storms, providing endless hours of fascination for curious onlookers. They also have a habit of floating near the surface of the water when they are sick or dying. Because of this, it is believed that the oarfish may be responsible for many of the legendary sightings of sea monsters and sea serpents by ancient mariners and beach goers.

The most noticeable feature of the oarfish is its extremely long, ribbon-like body reaching a length of over 50 feet (15 meters) and weighing as much as 600 pounds (272 kg). Its body is devoid of scales, covered with silvery or silvery-blue skin and is topped with an ornate, red dorsal fin that resembles a decorative headdress.

Oarfish that washed ashore in Bermuda in 1860, originally described as a sea serpent

In 2001 a live oarfish was filmed alive for the first time by a team of US Navy personnel repairing a buoy in the Bahamas. This specimen was observed swimming by undulating movement of its long dorsal fin, while keeping its body fairly straight. This type of propulsion is known as an amiiform mode of swimming. Oarfish have also been observed swimming in a vertical position.

Oarfish are a pelagic species found throughout the deep seas of the eastern Atlantic Ocean and Mediterranean Sea. They are usually found around 600 feet (200 meters) depths, although they are known to go as deep as 3,000 feet (1,000 meters) or as shallow as 60 feet (20 meters). It is possible that they move to shallower waters in search of food.

Adapted from : http://www.seasky.org/deep-sea/creatures-menu.html (Accessed 27, December, 2008)

DID YOU KNOW?

4.8 It is true that the oceans can continuously feed our curiosity for ever. But there are also several interesting facts related to the interaction of man with the sea and its resources. It would be fascinating to know 'Ama divers', 'cormorant

fishing', 'ghost net', 'glass floats' etc. We invite you to explore the section below and enrich your knowledge on these little known aspects.

Ama divers

Diving the deep oceans for harvesting the valuable pearls has been in vogue since time immemorial. Ama, Uminchu (in Okinawa Islands) or Kaito (in Izu Peninsula) are Japanese divers, famous for collecting pearls. The majority of Ama divers are women.

Unlike men, women naturally have more body fat, because of which they can stay warmer in colder water. This could have been a reason why the majority of Ama divers are women. Japanese tradition holds that the practice of Ama divers may be 2,000 years old. Traditionally, till as recently as the 1960s, Ama dived wearing only a loincloth. Even in modern times, Ama dive without scuba gear or air tanks, making them a traditional sort of free-diver. Depending on the region, ama may dive with masks, fins, and torso-covering wetsuits at the most. Only divers who work for tourist attractions use white, partially transparent suits.

Ama are famous for pearl diving, but originally they dived for food like seaweed, shellfish, lobsters, octopus, and sea urchins — and oysters which sometimes have pearls. Ama divers can keep diving well into old age. Usually they also undertake farm job.

Ama divers have figured in the famous Ian Fleming's James Bond series. Bond travels to Japan in the novel *You Only Live Twice* where he meets and marries Ama diver Kissy Suzuki. The character was also portrayed in the film version.

Adapted from: http://en.wikipedia.org/wiki/Category:Fishing_industry (Accessed 31 st December, 2008)

Cormorant fishing

This is a traditional fishing method in which fishermen use trained cormorants to fish in rivers. Historically, cormorant fishing was practiced in Japan, China and Macedonia, as well as several other places throughout the world.

The fishermen tie a snare near the base of the cormorant's throat to prevent the bird swallowing larger fish, which will be held in its throat. But the bird is allowed to swallow smaller fish. When a cormorant has caught a fish in its throat, the fisherman brings the bird back to the boat and make the bird spit the fish back up. Though cormorant fishing once used to be a successful fishing industry, its primary use today is to serve the tourism industry.

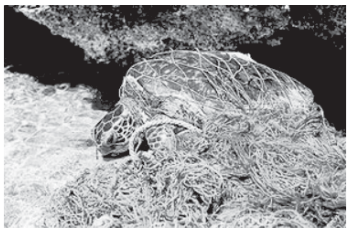
Cormorant fishing, called *ukai* in Japanese, takes place in 13 cities in Japan, the most famous location being Gifu. In Gifu Prefecture, cormorant fishing on the Nagara River has continued uninterrupted for the past 1,300 years. Only the cormorant fishing masters in Gifu and Seki were employed by the emperor and were called Imperial Fishermen of the Royal Household Agency.

Cormorant fishing was prevalent in Europe briefly from the 16th to 17th centuries, primarily in England and France. Though the fishing method was similar to those used in Japan and China, the European method was developed independently and was closely related to falconry. There are records of a form

of cormorant fishing practice in Peru back in the 5th century, outdating Japan's cormorant fishing by an entire century.

Adapted from : http://en.wikipedia.org/wiki/Fishing_techniques (Accessed 31 st December, 2008)

Ghost net



Ghost nets are fishing nets that have been discarded by fishermen or lost in the ocean in a storm, or simply forgotten. These nets, often nearly invisible in the dim light, may be left tangled on a rocky reef or may drift in the open sea. They can entangle fish, dolphins, sea turtles, sharks, dugongs, crocodiles, seabirds, crabs, and other creatures, including the occasional human diver.

Some commercial fisherman deploy gillnets by setting them in water and leaving for some time. The nets are lifted and the catch removed after a stipulated time. However if this is not done or the net could not be traced, the net will continue to catch fish (ghost fishing) until the weight of the catch exceeds the buoyancy of the floats. The net then sinks, and the fish are devoured by bottom-dwelling crustaceans and other fish. Then the floats pull the net up again and the cycle continues. Given the highly durable synthetic matrials in present day nets, the ghost fishing can continue for a long time.

Old fashioned crab pots are also play a damaging role since they can sit on the bottom and become self-baiting traps that go on catching crabs year after year. Even balled-up fishing line can be deadly for a variety of creatures, including birds and marine mammals.

Over time, the nets become more and more tangled and fouled with epiflora and fauna. In general, fish are less likely to be trapped in gear that has been down a long time. Some claim that ghost nets have a negligible impact upon marine ecosystems, as the catch of the ghost net is simply eaten by other marine life anyway.

The French government offered a reward for ghost nets handed in to local coastguards along sections of the Normandy coast between 1980 and 1981. The project was abandoned when people vandalised nets to claim rewards, without retrieving anything at all from the shoreline or ocean

Adapted from : http://en.wikipedia.org/wiki/Fishing_techniques

Glass floats

Glass floats (glass fishing floats, or Japanese glass fishing floats) are popular collectors' items. They were once used by fishermen in many parts of the world to keep their nets afloat. Long stretches of fishnets strung together, sometimes to make 50 miles (80 km) long, were set adrift in the ocean and supported near the surface by hollow glass balls or cylinders containing air to give them buoyancy.

Most floats are shades of green because that is the color of glass from recycled sake bottles The most prized and rare color is a red or cranberry hue. These were expensive to make because gold was used to produce the color.

Norway was the first country to start production and use of glass fishing floats around 1840. Christopher Faye, a Norwegian merchant is credited for the

invention. In the early 1800's, the Schimmelmanns Glassverk (1779 – 1832) produced dark brown and very thick, bottle glass floats.

By the 1940's, glass had replaced wood or cork throughout much of Europe, Russia, North American, and Japan. Japan started using the glass floats as early as 1910. Glass floats have since been replaced by aluminum, plastic, or Styrofoam.

The earliest floats, including most Japanese glass fishing floats, were hand made by a glassblower. Recycled glass, especially old sake bottles, was typically used and air bubbles in the glass are a result of the rapid recycling process.

When old netting breaks off of a float, its pattern often remains on the surface of the glass where the glass was protected under the netting. Today most of the glass floats left loose in the in the North Pacific ocean are stuck in a circular pattern of movement along with the ocean currents. Occasionally storms or certain tidal conditions will break some floats from this circular pattern and bring them ashore. Most floats that wash up, however, would have been afloat for 10 years or more. Once a float lands on a beach, it may roll in the surf and become 'etched' by sand.

Adapted from : http://en.wikipedia.org/wiki/Fishing_techniques

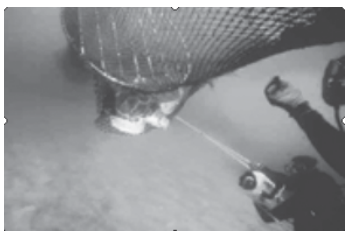
Lampuki netting

Lampuki is the Maltese name for the dorado or mahi-mahi, a kind of fish that migrates past the Maltese islands during the autumn. The fishing season for lampuki is from the end of August to November.

Fishermen cut and gather the larger, lower fronds from palm trees and weave large flat rafts out of it. The rafts are pulled out to sea, usually with the small traditional fishing boats known as Luzzu. During midday lampuki school underneath the rafts, seeking the shade. The fishermen use large mesh nets to catch the schooling lampuki. This method is known as 'kannizzati' and has not changed significantly since Roman times. The lampuki are used both for local consumption as well as export.

Adapted from : http://en.wikipedia.org/wiki/Fishing_techniques

Turtle Excluder Device (TED)



A turtle excluder device (TED) is a specialized device that allows escape of a turtle accidentally cught in a trawl net while allowing the fish catch to be retained in the cod end of the net. Sea turtles are caught in bottom trawls used by the commercial shrimp fishing industry. When a turtle gets caught in a trawl net, it becomes trapped and is unable to return to the surface for breathing air. If trawling continues for more than 45 minutes after capture, the turtle will eventually drown and die.

The TED consists of a metalic grid fixed at the mouth of the cod end at an angle. The grid acts as a barrier for large creatures such as turtles from passing through the bars into the back of the net. While small fish and shrimps easily

pass through the grid to the cod end. A small opening is provided in the net either at the upper or lower portion of the net in front of the grid. This opening acts as an escape chute for the creatures that are stopped by the grid.

TEDs were first developed in the 1970s by a fisherman called Sinkey Boone, seeking to reduce his by-catch. It was patented on April 26, 1988 by inventor Noah J Saunders of Biloxi, Mississippi. By decreasing the number of unwanted fish and creatures caught in their trawl nets, fishermen could trawl longer with the same net ideally catching more shrimp.

In 1987, the United States required all shrimp trawlers to equip their nets with turtle excluder devices. As a follow-up two years after, the shrimp-turtle law was implemented. Subsequently, USA extended this requirement to all countries exporting shrimp to USA. Countries that cannot guarantee the use of the TED were banned from exporting shrimp to the USA.

In 1996, the Indian government proposed legislature for the requirement of modified indigenous TEDs called Turtle Saving Devices (TSDs) to be used by local fishermen. This was a response to the declining olive ridley population that were nesting in beaches such as in Orissa. The modified TSDs were similar to standard TEDs except for having fewer bars to ensure that bigger specimens of shrimp and fish were able to pass through the TSD into the cod end of the net.

Adapted from : http://en.wikipedia.org/wiki/Fishing_techniques

Noodling

Noodling is a southern US practice of fishing for catfish using only bare hands. Many other names, such as catfisting, grabbling, graveling, hogging, dogging, gurgling, tickling and stumping, are used in different regions for the same activity. Noodling is currently legal in eleven states.

The term noodling is currently used primarily to denote the capture of flathead catfish, though it has been applied to all hand fishing methods, regardless of the method or species of fish sought. Although the concept of catching fish with only the use of the arm in the water is simple enough, the process of noodling is more complicated. The choice of catfish as the prey is not arbitrary, but comes from the circumstances of their habitat.

Flathead catfish live in holes or under brush in rivers and lakes and thus are easy to capture due to the static nature of their dwelling. To begin, a noodler goes underwater to depths ranging from only a few feet to up to twenty feet, placing his hand inside a discovered catfish hole. If all goes as planned, the catfish will swim forward and latch onto the fisherman's hand, usually as a defensive maneuver in order to try to escape the hole. If the fish is particularly large, the noodler can hook the head around its gills.

Most noodlers have spotters who help them bring the catfish in, either to shore or to their boat. When a catfish bites onto a noodler, it holds on for quite a while. Noodling can result in superficial cuts and minor wounds to the noodler. This can be reduced by wearing gloves and other protective clothing. Losing fingers is also a risk, whether from the bite or infection. Most holes are deep enough

that diving is needed, so there can be a danger of drowning. The Argungu Fishing Festival in northern Nigeria is perhaps the biggest noodling contest in the world.

Adapted from : http://en.wikipedia.org/wiki/Fishing_techniques

Gigging is not Jigging

Gigging, not to be confused with jigging, is an American South and Midwest practice of hunting suckers, flounder or frogs with a gig, or similar multi-pronged spear. A gig can refer to any long pole which has been tipped with a multi-pronged spear. The gig pole ranges in length from 8 to 14 feet for fish gigs and 5 to 8 feet for frog gigs. A gig typically has three or four barbed tines similar to a trident, however gigs can be made with any number of tines.

Suckers are a bottom-feeding fish common throughout many parts of the US. The gigging of suckers for food occurs predominately in southern Missouri and northern Arkansas. Sucker gigging is usually done at night with lights to maximize the visibility of the fast moving fish.

Modern sucker gigging uses specially constructed jon boats that have a set of lights mounted on the bow of the boat and a railing around the bow that allows the "gigger" to stand up and peer out in front of the boat in an attempt to locate and gig fish. The lighting system is often powered by gas, a generator, or a battery.

Flounder or flatfish live in coastal shallow waters and lie at the bottom waiting for shrimp or minnows to swim nearby. Flounder gigging is often more successfully done at night using powerful lights. This method targets nocturnally foraging fish, the light being used to spot the normally camouflaged fish.

Adapted from : http://en.wikipedia.org/wiki/Fishing_techniques

Payaos -an FAD

A payaos is a type of fish aggregating device used in Southeast Asia, particularly in the Philippines. Payaos were traditionally bamboo rafts for handline fishing before World War II, but modern steel payaos use fish lights and fish location sonar to increase yields. While payaos fishing is sustainable on a small scale, the large scale, modern applications have been linked to adverse impacts on fish stocks.

A traditional payaos is a simple bamboo raft with a superstructure at or just below the waterline, most commonly constructed of palm fronds. Hand line fishermen use payaos to take advantage of pelagic fish's attraction to floating objects. Large tuna can be caught in this manner at depths less than 300 meters, far shallower than by contemporary methods like purse seining. Payaos are frequently anchored in the coastal waters, passively attracting migrating fish.

The traditional payaos hve been modified and adapted to meet the demand for commercially fishing. They are now commonly used in conjunction with purse seineers, pump boats, and gillnet fishing. The success of these methods has greatly increased the pressure on fish stocks. The use of lighted payaos to attract fish has also had a large impact on catch size and profitability, and by the 1980s over 2,000 commercial payaos were in use in the Moro Gulf alone.

The drifting payaos using seines, as well as the lighted anchored payaos, catch juvenile tuna thereby affecting the lifecycle of the tuna beyond the simple loss of numbers from the catch. No international policy has been set on the placement of payaos, and many are currently deployed in sea lanes, presenting a navigational hazard. The replacement of bamboo with steel cages has also increased potential danger from collision and entanglement.

Adapted from : http://en.wikipedia.org/wiki/Fishing_techniques

Sardine Run

The sardine run occurs between May and July when millions of sardines especially, the Southern African pilchard (*Sardinops sagax*), spawn in the cool waters of the Agulhas Bank and move northward along the east coast of South Africa. Their sheer numbers create a feeding frenzy along the coastline. The run, containing millions of individual sardines, occurs when a current of cold water heads north from the Agulhas Bank up to Mozambique where it then leaves the coast line and goes further east into the Indian Ocean.

In terms of biomass, researchers estimate the sardine run could rival East Africa's great wildebeest migration. The shoals are often more than 7 km long, 1.5 km wide and 30 meters deep and are clearly visible from spotter planes or from the surface.

However, little is known of the phenomenon. It is believed that the water temperature has to drop below 21°C in order for the migration to take place. In 2003, the sardines failed to 'run' for the third time in 23 years. While 2005 saw a good run, 2006 marked another non-run.

Sardines group together when they are threatened. This instinctual behaviour is a defense mechanism as individuals are more likely to be eaten than large groups. These bait balls can be 10-20 metres in diameter and extend to a depth of 10 metres. The bait balls are short lived and seldom last longer than 10 minutes. Dolphins are largely responsible for rounding up the sardines into bait balls. Once the sardines are rounded up, sharks, game fish and birds take advantage of the opportunity. The Cape Fur Seal follows the shoals up the Eastern Cape coastline as far as Port St Johns.

Adapted from: http://en.wikipedia.org/wiki/Fishing_techniques

Ocean dumping

Deliberate disposal of wastes at sea is called ocean dumping. Oceanic debris tends to accumulate at the centre of gyres and on coastlines, frequently washing ashore, when it is known as beach litter . Some forms of marine debris, such as driftwood, occur naturally, and human activities have been discharging similar material into the oceans for thousands of years. Ocean dumping, accidental container spillages, and wind-blown landfill waste are all contributing to this problem.

A wide variety of anthropogenic artefacts can become marine debris; plastic bags, balloons, buoys, rope, medical waste, glass bottles and plastic bottles, cigarette lighters, beverage cans, styrofoam, lost fishing line and nets, and various

wastes from cruise ships and oil rigs are among the items commonly found to have washed ashore.

A 1994 study of the seabed using trawl nets in the North-Western Mediterranean around the coasts of Spain, France and Italy reported a particularly high mean concentration of debris; an average of 1,935 items per square kilometre. Plastic debris accounted for 77%, of which 93% was plastic bags. One famous spillage occurred in the Pacific Ocean in 1992, when thousands of rubber ducks and other toys went overboard during a storm. The toys have since been found all over the world; Curtis Ebbesmeyer and other scientists have used the incident to gain a better understanding of ocean currents. It has been estimated that container ships lose over 10,000 containers at sea each year (usually during a storm).

Though it was originally assumed that most oceanic marine waste stemmed directly from ocean dumping, it is now thought that around four fifths of the oceanic debris is from rubbish blown seaward from landfills, and urban runoff washed down storm drains.

Adapted from: http://en.wikipedia.org/wiki/Marine_debris

Marine snow

In the deep ocean, marine snow is a continuous shower of mostly organic detritus falling from the upper layers of the water column. Its origin lies in activities within the productive photic zone. The prevalence of marine snow changes with seasonal fluctuations in photosynthetic activity and ocean currents.

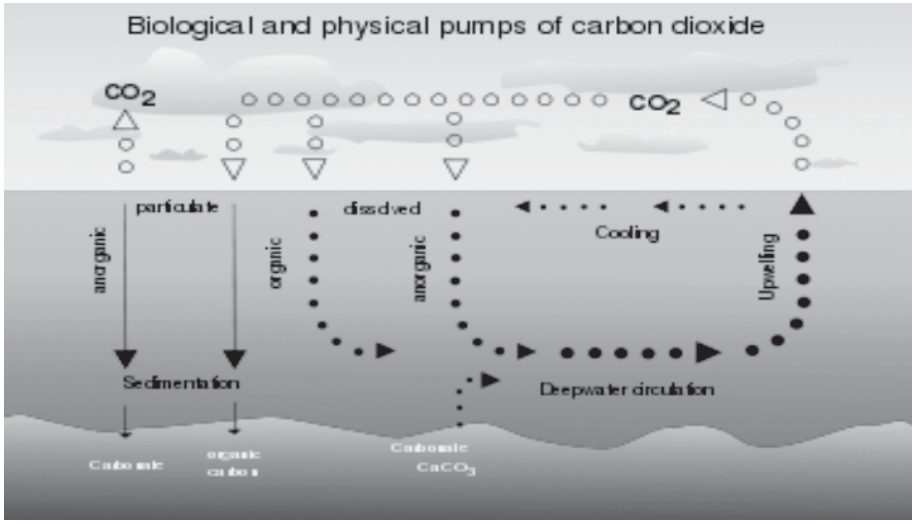
Marine snow has a composition which includes: dead or dying animals and plants (plankton), protists (diatoms), fecal matter, sand, soot and other inorganic dust. The "snowflakes" (which are more like clumps or strings) are aggregates of smaller particles held together by a sugary mucus, transparent exopolymer particles (TEPs); natural polymers exuded as waste products by bacteria and phytoplankton. These aggregates grow over time and may reach several centimetres in diameter, travelling for weeks before reaching the ocean floor.

However, most organic components of marine snow are consumed by microbes, zooplankton and other filter-feeding animals within the first 1,000 metres of their journey. This way marine snow may be considered the foundation of deep-sea mesopelagic and benthic ecosystems. Marine snow has begun to garner interest from microbiologists, owing to the microbial communities associated with it. Increasing stratification decreases the availability of phytoplankton nutrients such as nitrate, phosphate and silicic acid, and could lead to a decrease in primary production and, thus, decline in marine snow

Adapted from: http://en.wikipedia.org/wiki/Marine

Biological pump

In oceanic biogeochemistry, the biological pump is the sum of a suite of biologically mediated processes that transport carbon from the surface euphotic zone to the ocean's interior. The organic carbon that forms the biological pump is transported primarily by sinking particulate material, for example dead



organisms (including algal mats) or faecal pellets. However, some carbon reaches the deep ocean as dissolved organic carbon (DOC) by physical transport processes such as downwelling rather than sinking.

Carbon reaching the deep ocean by these means is either organic carbon or particulate inorganic carbon such as calcium carbonate ($CaCO_3$). The former is a component of all organisms, the latter only of calcifying organisms, for example coccolithophores, foraminiferans or pteropods.

In reference to the different use of these materials in organisms, the organic carbon portion of this transport is known as the soft tissues pump, while the inorganic carbon portion is known as the hard tissues pump. The biological pump has a physico-chemical counterpart known as the solubility pump.

Climate change may affect the biological pump in the future by warming and stratifying the surface ocean. It is believed that this could decrease the supply of nutrients to the euphotic zone, reducing primary production there. Also, changes in the ecological success of calcifying organisms caused by ocean acidification may affect the biological pump by altering the strength of the hard tissues pump. This may then have a "knock-on" effect on the soft tissues pump because calcium carbonate acts to ballast sinking organic material.

http://en.wikipedia.org/wiki/Biological_pump (Accessed 28, December, 2008)

Dead zone

Dead zones are hypoxic (low-oxygen) areas in the world's oceans, the observed incidences of which have been increasing since oceanographers began noting them in the 1970s. These zones occur near inhabited coastlines, where aquatic life is most concentrated. (The vast middle portions of the oceans which naturally have little life are not considered "dead zones".) The term can also be applied to the identical phenomenon in large lakes.

In March 2004, when the recently-established UN Environment Programme published its first Global Environment Outlook Year Book (*GEO Year Book 2003*) it reported 146 dead zones in the world oceans where marine life could

not be supported due to depleted oxygen levels. Some of these were as small as a square kilometre (0.4 mi²), but the largest dead zone covered 70,000 square kilometres (27,000 mi²). A 2008 study counted 405 dead zones worldwide.

Aquatic and marine dead zones can be caused by an increase in chemical nutrients in the water, known as eutrophication. Chemical fertilizer is considered the prime cause of dead zones around the world. The Pacific coast of the United States between California and Washington has a 1120 square mile (2900 km²) dead zone caused by stronger winds that many associate with global warming.

Low oxygen levels recorded along the Gulf Coast of North America have led to reproductive problems in fish involving decreased size of reproductive organs, low egg counts and lack of spawning. It might be expected that fish would flee this potential suffocation, but they are often quickly rendered unconscious and doomed. Slow moving bottom-dwelling creatures like clams, lobsters and oysters are unable to escape. All colonial animals are extinguished. The normal re-mineralization and recycling that occurs among benthic life-forms is stifled.

Dead zones are reversible. The Black Sea dead zone, previously the largest dead zone in the world, largely disappeared between 1991 and 2001 after fertilizers became too costly to use following the collapse of the Soviet Union and the demise of centrally planned economies in Eastern and Central Europe. Fishing has again become a major economic activity in the region.

Adapted from: http://en.wikipedia.org/wiki/Dead_zone_(ecology)

Oil spill

An oil spill is the release of a liquid petroleum hydrocarbon into the environment due to human activity, and is a form of pollution. The term often refers to marine oil spills, where oil is released into the ocean or coastal waters. Spills take months or even years to clean up.

Oil is also released into the environment from natural geologic seeps on the sea floor. Most human-made oil pollution comes from land-based activity, but public attention and regulation has tended to focus most sharply on seagoing oil tankers.

The oil penetrates and opens up the structure of the plumage of birds, reducing its insulating ability, and so making the birds more vulnerable to temperature fluctuations and much less buoyant in the water. It also impairs birds' flight abilities, making it difficult or impossible to forage and escape from predators. As they attempt to preen, birds typically ingest oil that coats their feathers, causing kidney damage, altered liver function, and digestive tract irritation. This and the limited foraging ability quickly causes dehydration and metabolic imbalances. Most birds affected by an oil spill die unless there is human intervention.

Marine mammals exposed to oil spills are affected in similar ways as seabirds. Oil coats the fur of Sea otters and seals, reducing its insulation abilities and leading to body temperature fluctuations and hypothermia. Ingestion of the oil causes dehydration and impaired digestion.

Adapted from: http://en.wikipedia.org/wiki/Oil_spill

Duck covered in oil as a result of the 2007 San Francisco Bay oil spill.

CONTINENTAL DRIFTPangaea broke up with part of the continent drifting north and part south. 1) The northern part split to form the North Atlantic Ocean 208-146 million years ago (mya). 2) The South Atlantic and Indian oceans began to form 146-65 mya. 3) The continents continue to drift. Today the oceans are still changing shape; the Atlantic Ocean gets wider by a few inches each year.

The changing oceans

The face of the Earth is always changing and throughout geologic history oceans have been created and destroyed. Modern geologic evidence indicates that the ocean bottom is moving at a rate from about one-half to six inches a year through a process called plate tectonics.

Roughly 200 million years ago the Earth's surface was very different from the familiar pattern of land we know today. All of the land masses were grouped together into one vast supercontinent called Pangaea. The rest of the globe was covered by a single great ocean known as Panthalassa

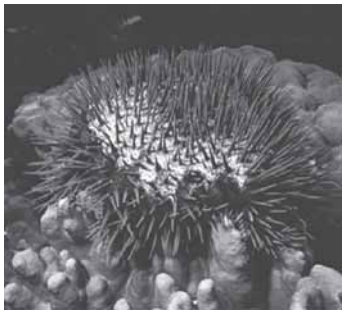
Adapted from: http://www.mos.org/oceans/index.html (Accessed 3 January, 2009)

Bits of Gondwanaland

The Seychelles Islands were formed millions of years ago from bits of Gondwanaland that were cast adrift when the Indian continent drifted north toward Asia. The Seychelles are made up of 115 islands that can be divided into 2 types: the 42 granitic islands that make up this ecoregion, and low limestone islands. The Seychelles Islands are justly famous for their coral reefs and the remote Aldabra Atoll - the largest raised atoll in the world. It supports a huge coral diversity and rare land species like the giant tortoise (Aldabra has the largest population). This ecoregion is also home to the very last known population of flightless birds in the western Indian Ocean, and it provides valuable breeding areas for both marine turtles and seabirds. In recognition of its status it is listed as a natural World Heritage site by UNESCO.

http://www.panda.org/about_wwf/where_we_work/ecoregions/ (Accessed 3 January, 2009)

Crown of thorn Starfish



Crown of thorn starfish (*Acanthaster planci*) is a reddish and heavy-spined species of the phylum Echinodermata. It has from 12 to 19 arms, often 45 cm (18 inches) across, and feeds on coral polyps. Beginning about 1963 the numbers of this species increased enormously on Australia's Great Barrier Reef. The population explosion was attributed to the decimation of its chief predator, a large marine snail, the Pacific triton (*Charonia tritonis*), by shell collectors. Thereafter, the starfish multiplied throughout the southern Pacific up to Hawaii by about 1970, seemingly threatening the destruction of coral reefs and islands. However, new research data indicated that similar expansions, or blooms, had occurred previously, followed by periods of decline. Thus it seemed likely that the sudden growth of the starfish population during the 1960s represented a phase in the organism's natural cycle.

Starfishes prey upon shellfish, coral polyps and even other starfishes. It slowly wraps its arms around the mussel in a hug and attaches its tube feet to the mussel pulling and pulling until the mussel weakens. As the shells separates, the starfish opens its mouth and extrudes its stomach under the mussel. The prey is partially digested externally. The stomach is then retracted and digestion is completed inside the body. The indigestible mussel shell is discarded.

Adapted from: http://en.wikipedia.org/wiki/Crown-of-thorns_starfish (accessed 06 January 2009)

Precious as Pearls

The richest merchandise of all, and most soveraigne commmmoditie throughout the world are these pearls

C. Plinius Secundus (Pliny the Elder) Roman historian and writer, from Natural History 77 AD

Pearls are formed in the bivalve mollusk, the pearl oyster which lives in the sea. The allure of the pearl is timeless and universal. Since the beginning of the recorded history, the pearl has been exolled as a metaphor of life itself, for virtue and love, wisdom and justice, spirituality and righteousness. Always graded as one of he rarest, most valuable of all gems, its praises are sung by the great poets of every age; it is praised in every culture, from ancient China, India, Persia, Egypt, Greece and Rome, to the Mayan, Aztec and Incan cultures of the Americas and even the ancient cultures of the south Pacific and Australia.

Over the years, pearls have been collected and treasured by many. There are large business houses trading both natural and cultured pearls. Given below are some magnificent natural pearls auctioned by international firms as described by Antoinette L.Matlins in *The Pearl Book – How to select, buy, care for & enjoy pearls,* published by the Gemstone Press, Woodstock, Vermont, in 1996. (Note: Pearls are measured in millimeters and weighed in grains. 1 carat = 4 grains; 1 carat =0.2 g)

La Regene: This is an egg-shaped pearl of 302.68 grains (15.1g), suspended from a cushion shaped diamond acanthus –leaf surmount, in silver and gold, sold by Christie's, Geneva, May 12, 1988, for $ 859,100. It was acquired by Napolean in 1811 for a sum of equivalent to $ 8,000 for his second wife Empress Marie-Lousie. It was subsequently given by Napolean III to his bride-to-be, Eugenie, as a measure of his love! Later during a political unrest, the "La Regenta" was acquired by a Russian master jeweler who sold it to the Russian Princess Zenaide Youssoupov.

The Sara Pearl: This is a drop shaped grey pearl weighing approximately, 292 grains (14.6 g), including the pave set diamond cap, sold by the Christie's, Geneva, May 21, for $ 470,600. The Sara pearl is of high importance because of its size and rare colour and its mysterious origins. The home source of this pearl is assumed to be island of Margarita, off the Venezulan coast. The pearl itself probably weighs about 220 grains (11 g), but over the years the gold cap weighing 50 to 70 grains) has become part of the pearl and it is impossible to detach it without ruining the pearl.

La Pelegrina: This is a pear shaped pearl of 133.16 grains (6.7 g) with rose cut diamond foliate cap and circular cut diamond surmount, sold by Christie's Geneva, May 14, 1987, for $ 463,800. Dating back to 17th Centuary, La Pelegrina was given by Philip IV to his daughter Maria Teresa on the occasion of her marriage to Louis IV of France. A pearl of this quality and size is one of a kind.

Elizabeth Taylor Present Owner of Famed Pearl

La Peregrina: This is a pear shaped drop pearl weighing approximately 204 grains (10.2 g), mounted on a platinum base with numerous rows of diamonds,

sold by Sotheby's New York, January 1969, for $ 37,000. This magnificent pearl, discovered in Panama in the mid sixteenth century, was found in an oyster so small that it was nearly thrown away unopened. The pearl was in the possession of the Spanish royal family for several centuries and later purchased by Elizabeth Taylor.

Adopted from: http://www.karipearls.com/index.html (accessed 3 January 2009)

ANSWERS

ACROSS

1. THERMOCLINE 7. BIOTA 8. TED 9. ZOOM 10. MEY
11. GENES 12. AIR 13. ONE 14. ELECTRIC EEL 17. INK

DOWN

1. TAB 2. ECOLOGY 3. MEAN 4. CATFISH 5.INDIAN OCEAN
6. ELVER 9. ZAMBEZI 15. NEKTON 16. ICE 18. LOA 19. ME

Answers to Picture Quiz

1. The sea cow	2. Sea fan	3. The cuttlefish
4. The mushroom coral	5. The whale	6. The sea hare
7. The sea anemone	8. The brine shrimp	9. The giant clam
10. The sea urchin	11. Barnacles	12. Hammer-headed shark
13. The sacred chank	14. Young turtles	15. Lion fish/Scorpion fish

Voices of Concern

Gary Sharp (1995) has voiced his concern that fisheries studies have simply ignored climate signals or have buried these and other environmentally mediated signals in mystical parameters. He called for truly interdisciplinary approaches to aquatic ecology and marine fisheries research and reincorporating of operational oceanography and climatology into fishery science. While observing that 'for some obscure reason, fisheries management has become welded to biomass as the principal measure of resource status', he points out that stock assessment tools need to be expanded to cope with ecosystem status. In fact Sverdrup (1952) had succinctly explained much earlier the practical aspects of fishery oceanography with respect to prediction of the availability and size of the stock of any exploited species of fish. These voices are reflected in the new approaches of fisheries management being evolved at various places.

Sharp, G. 1995. It's about time: new beginnings and old good ideas in fisheries science. *Fisheries Oceanography.* 4: 324-341.

Sverdrup, H. U. 1952. Some remarks on the place of hydrography in fisheries research. (*Rapp. Intern. Cnoseil Expl. Mer*. 131). pp. 152-154. In: Thomassen E. M. (Ed.) 1981. *Study of the Sea*. Fishing News Books. Osney Mead, Oxford.

ABOUT MBAI

The Marine Biological Association of India was established in the year 1958 and serves the cause of promotion of research on marine sciences in the Asia-Pacific region. Enshrined in the articles of the association is the primary cause to create among its members an active interest in the field of marine biology and allied marine sciences. The association carries out this objective by:

- Organising lectures, symposia and seminars on specific subjects
- Offering requisite information to research workers and students undertaking research in marine biological sciences
- Publishing a journal called the Journal of the Marine Biological Association of India
- Publishing occasional Memoirs, Monographs and Bibliographies on topics of current interest in marine biology
- Instituting fellowships and studentships to research workers at various recognized institutions
- Sponsoring and aiding expeditions in Indian seas
- Institution of prizes in recognition of outstanding contributions towards advancement of marine biological sciences

The Association has both individual and institutional members numbering nearly 1000 from all over the world. During the past 50 years, the Association has conducted a number of international symposia focussing attention on specific areas of topical interest in marine biology. These were on Scombroid fishes (1962); Crustacea (1965); Mollusca (1968); Corals and Coral Reefs (1969); Indian Ocean and Adjacent Seas (1971); Coastal Aquaculture (1980); Endangered Marine Animals and Marine Parks (1985); Tropical Marine Living Resources (1988) and Eco-friendly Mariculture Technologies (2000).

The papers presented in the symposia have been published as proceedings which have been well received in different parts of the world. The monographs, memoirs and bibliographies published by the MBAI are widely used by the scientific community.

The official organ of the Association, the Journal of the Marine Biological Association of India (JMBAI) has until now been published in 49 volumes containing over 4000 scientific papers. Most of these papers are of seminal nature, and therefore, the journal has attained the status of a premier journal in the field with a NAAS impact factor of 3.0.

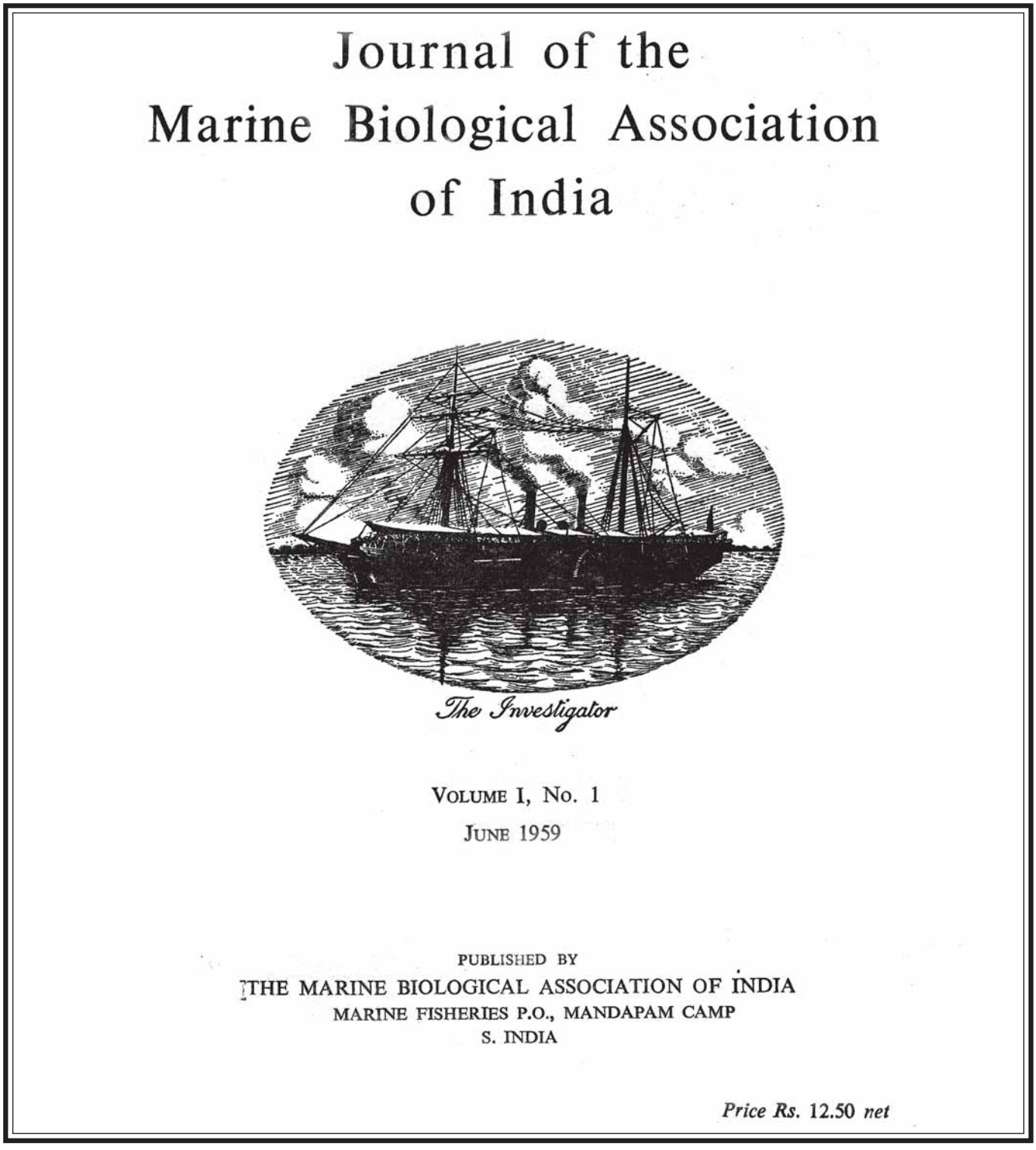
The Association is administered by a President, two Vice-Presidents, a Secretary, an Associate Secretary, a Treasurer, an Editor with two Associate Editors and six executive members. The Association functions from within the premises of the Central Marine Fisheries Research Institute (CMFRI) at Cochin, Kerala State, India.

MBAI ACTIVITY MILESTONES

EVENTS	YEAR
The MBAI, Kochi was established	1958
Formerly inaugurated by Mrs. Lourdhammal Simon, Minister for Local Administration and Fisheries, Madras State	3rd Jan. 1959
First Volume of *JMBAI* released	June 1959
First International Symposium on *Scombroid fishes*	1962
Symposium on *Crustacea*	1965
Symposium on *Mollusca*	1968
Symposium on *Corals and coral reefs*	1969
Symposium on *Indian Ocean and Adjacent Seas*	1971
Symposium on *Coastal Aquaculture*	1980
Celebrated Silver Jubilee of *MBAI*	1983
Symposium on *Endangered Marine Animals and Marine Parks*	1985
Symposium on *Tropical Marine Living Resources*	1988
Symposium on *Eco-friendly Mariculture Technologies*	2000
Inaugurated the Golden Jubilee celebrations	5th June 2008
Launched MBAI website www.mbai.org.in	5th June 2008
First Announcement of MECOS-09 released	5th June 2008
Golden Jubilee issue of *JMBAI* Vol. 50 No. (1) released	June 2008

3.4 Image Gallery

The front cover of the first issue of JMBAI



Pictorial Milestones of MBAI

Inaugural Function of MBAI on 3rd January 1959

Inaugural address by Hon. Minister Mrs. Lourdhammal Simon, Minister for Local Administration and Fisheries. To her right is Mr. P.P.I. Vaidyanathan, I.C.S., Secretary, Government of Madras.

Welcome by Dr. S. Jones President of the Association. To his left are Mr. N. Murugesa Mudaliar, Deputy Secretary, Government of Madras and Mr. C.P. Kelu Erady, I.A.S., Director of Fisheries, Madras.

Vote of thanks by Dr. R. Raghu Prasad, Secretary of the Association.

Pictorial Milestones of MBAI

Dr. N.R. Menon releasing the JMBAI with new cover

Prize distribution of the Dr. S. Jones Memorial Marine Life Quiz held at Cochin in 2004

Glimpses of Tamil Nadu State Level Marine Life Quiz held on 17 December 2008

Pictorial Milestones of MBAI

MBAI Marine Life Quiz at Mangalore held on 15 August 2008

A view of the audience

The winning team of Marine Life Quiz

The winner of Marine Life Painting

The team behind

MECOS-09 ORGANIZING COMMITTEES

Convenor

N.G. K. Pillai, CMFRI

Co- Convenor

K.S. Mohamed, CMFRI

Chairperson Organising Committee

E.G. Silas

Reception Chairman

G. Syda Rao

K. Raman
V.N. Pillai
P.V. Rao
N. Ramachandran
Anwar Hashim
P.R.S. Thampi
P.T. Meenakshisundaram
P.V.R. Nair
N.R. Menon
K.K.C. Nair
G. Mohankumar
G.H. Manikfan
K. Devadasan
B. Meenakumari
B. Madhusoodhana Kurup
Saleena Mathew
V.N. Sanjeevan
N. Bahuleyan
Benjamin Varghese
S. Girija
V.K. Pillai
K.J. Mathew
D. D. Nambudiri
G. Sudhakar Rao
K. Satyanarayana Rao
G. Subbaraju
Roja Sethumadhavan
G.P. Sharma

Help Desk

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Rani Mary George
Somy Kuriakose
Manju Sebastian
K.V. Akhilesh

Counter Registration

V. Kripa (Chairperson)
U. Ganga
Joslin Jose
Rekha J. Nair
D. Prema
G. Subbaraman
Bindu Sanjeev
U. Manjusha
M.S. Menaka

Abstracts

E. Vivekanandan (Chairman)
A. Gopalakrishnan
K.V. Jayachandran
T.S. Naomi
T.M. Najmudeen
M. Harikrishnan

Traditional Welcome Arrangement

Mary K. Manissery (Chairperson)
K.S. Shobhana
K.G. Mini
Manjusha G. Menon

Programme Co-ordination

G. Gopakumar (Chairman)
Mary K. Manissery
V.K. Pillai
C.P. Gopinathan
M.R. Bhupendranath
E. M. Abdussamad
A.P. Dineshbabu
Prathibha Rohit
P. Laxmilatha
Rani Palaniswamy

Exhibition

R. Sathiadhas(Chairman)
V.P. Vipin Kumar
T.M. Najmudeen
K.P. Salini
P.R. Abhilash
K.V. Jackson

Poster Session

V.S. Basheer, (Chairman)
Raja Swaminathan
P.R. Divya, NBFGR
Renjith Kumar
K.A. Sajila
N. Beni

Rapporteuring, Draft Session Report Preparation

P.C. Thomas (Chairman)
M.S. Rajagopalan
Grace Mathew
K. Vijayakumaran
K.V. Jayachandran
Rajasekharan Nair
Bijoy Nandan
Geetha Sasikumar
C. Ramachandran
K. Vijayagopal
V.D. Deshmukh
P. Kaladharan
M.R. Boopendranath
Narayana Kumar
N. Aswathy
P.P. Manojkumar
M. Sivadas
Joselin Jose
Imelda Joseph
K. Madhu
M. Harikrishnan, CUSAT

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M. Antony Joseph,
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K. Asokakumaran Unnithan
K. Vijayakumaran
V.P. Vipin Kumar
J. Narayanaswamy

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A. Gopalakrishnan
P.U. Zacharia

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T.S. Sajith
Jackson K.V.
B. Anoop

Airport GuestManagement

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K.S.S.M. Yousuf
Reynold Peter
B. Jabbar

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T.B. Ratheesh

Sinages, Banners & Certificates

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T.P. Babeesh

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A.P. Dinesh Babu
K.K. Philipose

Cultural Programme

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K.S. Mohamed
Somy Kuriakose
P. Krishnakumaran
G. Subbaraman

National Research Centre for Women in Agriculture (ICAR)

Bhubaneswar, Orissa

The working group on Agricultural Research and Education constituted by the planning commission for the formulation of the Eight Five year plan (1992-197) recommended for establishment of a National Research Centre for Women in Agriculture (NRCWA). Accordingly, the Indian Council of Agricultural Research established the NRCWA in the month of April 1996 at Bhubaneswar. The Sub-Centre of NRCWA is located at the Campus of CIAE, Bhopal. In XIth Plan EFC National Research Centre for Women in Agriculture (NRCWA) has been upgraded to Directorate of Research on Women in Agriculture.

Mandate

To identify gender issues and test appropriateness of available farm technologies, programmes and policies with women perspective for promoting gender mainstreaming in research and extension for empowerment of farmwomen and capacity building of scientists, planners and policy makers to respond to the needs of the farm women.

Objectives

- To create a database on gender specific information about men's and women's role in food production and agriculture development for effecting technologies, programmes and policies.
- To test the appropriateness of farm technologies and programmes and policies in terms of gender sensitivity in collaboration with relevant national and international organizations and suggest suitable modifications.
- To develop drudgery reducing options for decreasing the workload and increasing the efficiency of women.
- To develop gender sensitive modules and methodologies for transfer of technology.
- To develop gender sensitive training modules and materials and impart training for capacity building of scientists, researchers, planners and policy makers for gender mainstreaming and practical application of gender related technologies.
- To develop and publish gender sensitive materials, create network linkage through journals and information sharing.

Thrust Areas

- Creating a repository of gender disaggregated data and documentation
- Technology testing and refinement
- System development and management
- Drudgery assessment and reduction
- Gender sensitive extension approach
- Capacity building of scientists and functionaries
- Efficient resource management
- Gender mainstreaming.

AICRP on Home Science
National Research Centre for Women in Agriculture (ICAR)

NRCWA is lead centre for All India Coordinated Research Project of Home science with Coordinating units in 9 state agriculture universities Viz; AAU, Jorhat, ANGRAU, Hyderabad, HAU, Hissar, CSKHPKV, Palampur, GBPUA &T Pantnagar, MPUA&T, Udaipur, MAU Parbani, PAU, Ludhiana, UAS, Bangalore and UAS, Dharwad with an outlay of Rs. 3957.34 lakh.

For more information please contact
Dr. Krishna Srinath, Director NRCWA
Ph. No. +91-674-2384241, Fax : +91-674-2384242
or visit website : http://www.nrcwa.org or
e-mail : nrcwa@ori.nic.in

NATIONAL RESEARCH CENTRE ON COLDWATER FISHERIES

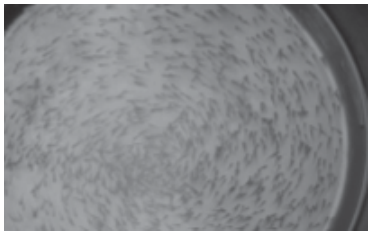
(Indian Council of Agricultural Research)

Introduction

The National Research Centre on Coldwater Fisheries (NRCCWF) was established in September 1987 by Indian Council of Agricultural Research (ICAR). The Centre is located at Bhimtal, Nainital in the state of Uttarakhand. The main objective of its establishment was to strengthen fishery research in coldwater sector encompassing the Himalayan and peninsular parts of the country. From September 2003, the centre is operating in its own complex at Bhimtal. The research programmes undertaken by the Centre are designed with major thrust on open water fisheries and aquaculture and conservation. The organization is working on institutional and sponsored projects. The institute is providing services and utilities several frontline areas. The institute imparts need based training in coldwater fisheries for the University students, fish farmers, personnel of state fisheries departments, NGOs and other organizations. Centre has linkages with State Agricultural Universities: G.B. Pant University of Agriculture and Technology, Pantnagar (Uttarakhand), H.P. Krishi Vishwavidyalaya, Palampur (Himachal Pradesh) and S.K. University of Agricultural Sciences and Technology, Srinagar (Jammu & Kashmir) Rajiv Gandhi University, Arunachal Pradesh and other Universities of NE region and other sister ICAR institutes.

Mandate

1. To conduct basic strategic and applied research in coldwater fisheries and aquaculture.
2. To develop management model and culture technologies for major coldwater fish species.
3. To create awareness and provide training and consultancies.



Mission

1. Diseases diagnosis in coldwater fisheries.
2. Genetic improvement with marker assisted selection.
3. Water conservation and management.
4. Low volume and high value species

Achievements

- Artificial breeding of golden Mahseer and designing & fabrication of flow through hatchery for mass scale production of Mahseer seed.
- Development of mahseer fishery in Shyamlatal Lake, Bhimtal Lake and the rivers and stream for conservation and sport.
- Formulation of diets for Golden Mahseer, Snow-trout and Rainbow Trout.
- Mixed farming system for uplands based on exotic Chinese carp viz., Common carp, Silver carp and Grass carp.
- Induced breeding technique for grass carp and silver carp in coldwater.
- Artificial propagation and seed raising of chocolate mahseer in NEH Region, Arunachal Pradesh and Uttarakhand.
- Rearing and breeding of rainbow trout in the Kumaon Region.
- Environment impact assessment in the temperature waters.
- Ecological management for fishery enhancement in Hill wetlands.

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Mandate of the Institute:

- To provide a research base to improve the productivity of important Agri-Horticulture, livestock and fisheries of A&N Islands through adaptive and basic research for attaining economic self sufficiency
- To develop appropriate plans for conservation of natural resources and their sustainable use
- To standardize technologies for animal health coverage and livestock production
- To standardize techniques for capture and culture fisheries including coastal aquaculture
- First line transfer of technology and training to the relevant state departments.

Divisions/Sections

1. Natural Resource Management Division
2. Horticulture & Forestry Division
3. Field Crops Division
4. Animal Science Division
5. Fisheries Science Division
6. Social Science Section

Salient Research Achievements of Fisheries Science Division

- ♣ Standardized technology suitable for island condition for induced breeding of tiger prawn (*M. rosenbergii)*.
- ♣ Standardized technology for induce breeding, seed raising and composite farming of Indian Major Carps suitable for in Island condition.
- ♣ Developed technology for captive breeding of marine ornamental clown anemone fish (*Amphiprian percula*).
- ♣ Generated information on coral and mangrove biodiversity and ecology.
- ♣ Developed suitable integrated farming system (IFS) models for different farming situations where fisheries in one of the important components.

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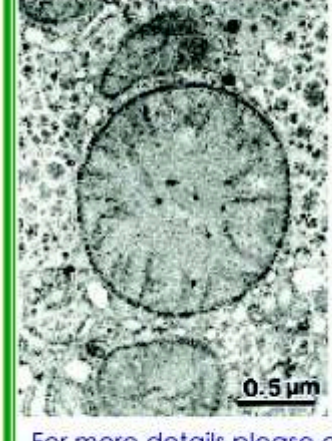

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