million tonnes. The higher requirement is due to diversion of food grains to meat, dairy and egg production where 3 parts of cereal are required for one part of these items of food.

Indian strategies should include promotion and popularization of cereals other than rice and wheat and agricultural research to evolve high-yielding varieties.

Oils and fats

India was an exporter of oil and oilseeds until 1961. It is now the major importer of edible oils.

It is clearly estimated that the requirements of 2400 calories per day cannot be met by cereals and pulses alone as it would need 800 g of dry cereals or about 3 to 4 kg of cooked wet product to be consumed. This is impossible. Whereas dry cereals contribute 3 calories per g or 0.7 to 0.8 calories in cooked food per gram, oils and fats provide 9 calories per gram. While requirements of essential fatty acids are met from small percentages present in cereals, a minimum of 15 g of visible fat are required per adult from edible oils and dairy products. Cereals are sold at about Rs 3 per kg. Purely in nutritional terms, fats should be available at Rs 9 per kg. Indian free market prices of fats and oils are Rs 30 to 50 per kg, outside the public distribution system (PDS). The lowest price for edible oil in the world market is about Rs 4 to 5. In free markets, oils are available at 3 to 4 times the price of dry cereal and this is a true representation of the calorific value of these materials. In India, in free market conditions, oils are available at 10 times the value of cereals per kg. This is a totally unacceptable situation. Oils should be sold at the most at 4 to 5 times of the price of cereals in free market or in PDS.

Malaysia produces now 6.2 million tonnes per annum of palm oil from 1.1 million ha averaging 5 tonnes per ha per annum. It plans to produce 10.2 million tonne by 1992. Indonesia, Nigeria, Congo and other equatorial countries are also increasing production of palm oil. Current Indian policies on pricing are based on low productivity of only 1.5 to 2.0 tonnes per ha of oilseeds or 0.6 to 0.8 tonnes of oil per ha from groundnut. India is the largest producer of groundnut and the lowest per-hectare producer in the world. Production of oilseeds bearing 40 to 45% of oils such as groundnut or mustard should be increased to 2.5 to 3.5 tonnes per ha in irrigated conditions to compete with cereals which yield 4 to 6 tonnes per ha. Yugoslavia has demonstrated production of 5.5 tonnes per ha of groundnut seeds. In India mustard has reached 3.5 tonnes per ha in good practice.

While India produces only 4.5 to 5.5 million tonnes of oil, Malaysia alone produces 6.2 million tonnes. There are those who argue that India should not aim at self-sufficiency in oils and fats but should import these at favourable prices. On nutritional grounds of providing minimum nutrition to the poor, this has merit unless Indian agriculture can develop systems to produce in farmers fields edible oilseeds of at least 2.5 to 3.5 tonnes per ha.

The real demand for oils at a price of Rs 12 to 15 in free market conditions would be 7 to 8 million tonnes per annum. This alone would provide minimum calories requirements to the poor. The country should concentrate on research towards increased productivity per ha and compete with cereals in economic returns. Agricultural research and technology transfer should concentrate on groundnut, mustard and sunflower with the objective of obtaining high reliable yields of 3 tonnes of oilseeds per ha. Given priority attention, our excellent agricultural scientists will no doubt achieve the target. They have already demonstrated yield of 3.5 tonnes per ha of winter mustard.

Palm cultivation is also now proposed. Yields of palm oil in Malaysia are of the order of 5 tonnes per ha. The best yields in India of oils in groundnut or mustard are only 1.3 tonnes per ha. Palm oil is obtained from the fruit pulp and it has to be crushed very quickly after harvest. Otherwise the fat is converted to fatty acid by enzyme action. It is necessary to have palm trees in continuous large area to allow collection and processing without delay. Malaysia has 1.1 million ha of palm. The oil produced costs Rs 4 to 5 per kg. Malaysia is experimenting with production of methylesters of palm fatty acids for use in automobiles and engines in replacement of diesel. Indian efforts at palm cultivation in Kerala are still in early stages. It is proposed to undertake trials in Coastal Karnataka in about 1000 ha. These are too small to make any impact on edible oil availability.

It is clear that edible oil demand is high and is rapidly rising. Indian dietary habits and cooking depend on frying. There is little use for baking in our cooking. Deep fried products are standard items in catering for all sections of the Society as high temperature and partial dehydration to low moisture levels ensure hygiene and absence of bacterial contamination. The process also releases flavours, and retains them in solution in oil. Urbanization and improved living standards lead to higher demand for vegetable oil.

A minimum of visible oil and fat is required in diet to meet energy needs, especially of those who carry out physically-demanding tasks. These energy needs cannot be met by cereals alone as the quantity of cooked cereals would be too large to be consumed in two or even three meals. Growing children and pregnant and lactating mothers require high amounts of energy and these too can be met only by additional fat in diet.

The quality of fat, and in particular the fatty acid composition is extremely important in nutrition. A minimum of polyunsaturated fats and a good ratio of unsaturated to saturated fats are essential. Indian vegetable oils such as groundnut, mustard, sesame, sunflower, safflower and rice bran are entirely satisfactory for nutrition. Soybean and niger seed oil also meet these standards. Palmolein is also adequate for nutrition.

The vanaspati industry has grown to be a major one supplying one million tonnes or 20 to 25% of total visible fat. The standards for vanaspati were prescribed with the object of replacement of ghee on the one hand and prevention of adulteration of ghee by cheaper vanaspati. These objectives are no longer valid as vanaspati is an established distinctive product and marketed by brand names. Ghee is also marketed in branded packs and adulteration is not an issue. It appears that any hydrogenation of edible oils should be such as to produce a solid product with melting point of 33 to 40°C. Such excessive hydrogenation converts the desirable poly and mono unsaturated fat into saturated fat which is not nutritionally attractive. Hydrogenation to a small degree in case of soybean can reduce linolenic acid which produces off flavour in frying. It is necessary to revise regulations on hydrogenation. There should be much flexibility in degree of hydrogenation with a limit on maximum melting point. Other processes such as inter-esterification should also be permitted. Indian regulations are antiquated and do not recognize advances in knowledge in nutrition and processing.

Milk fat is an important element in dietary. It is largely invisible as ghee and butter are not significant quantitively. However milk fat is more saturated and has a low ratio of unsaturated to saturated fat compared to liquid vegetable oils. Buffalo milk has twice the fat content as cow's milk. Milk fat is very expensive and is an item of luxury. Indian regulations, on dairy products such as ice cream and sweets, stipulate that they should not contain non-milk ingredients such as vegetable oil or vanaspati. However other products such as chocolate, cakes or biscuits use non-dairy fat. These regulations are arbitrary and need revision to reflect consumer interest in lower prices and scientific knowledge in nutrition.

In summary, it is necessary to redefine total natural needs of oils and fats. Demands should be based on making available oils and fats at four to five times the price of cereals in due course. High procurement prices for oilseeds are necessary to provide incentive to farmers but these should be accompanied by efforts at irrigated rather than rain-fed cultivation, high yields and improved processing. Imports have to supplement local production for several years. Government gains, by imports at low prices and sale at higher prices, are considerable amounting to about Rs 1000/- crores for a million tonnes of imported oil. At least a good proportion should be made available for research and development to improve oil production and extraction and attain efficiency and lower costs for the consumer. Foreign exchange for imports of vegetable oil produces the highest revenue to Government compared to all other imports and yet very little is made available to innovative efforts for reducing such imports.

Margarine for table and bakery use, with colour and flavour is internationally accepted. Mixture of butter and margarine is also promoted in the interests of nutrition and the consumer as whole butter does not have adequate unsaturated and polyunsaturated fat. Indian regulations still preclude use of colour and flavour and there is no scientific basis for continuance of these. The consumer's interests are also not protected. These need review urgently.

Present policies lead to excessively high consumption of fats by richer sections and very low availability for the poor and needy. Even the sale in PDS cannot remedy this as long as free market prices are high. The rich and middle class should be educated and sensitised to reduce high fat intake as it is harmful. Government and public institutions may set an example by reducing sale of fried snacks in canteens. Special incentives should be given to baking and steaming.

Protein

The importance of protein in diet especially for infants, children and pregnant and lactating mothers, is well recognized. Fortunately Indian cereals and pulses, consumed at adequate levels to meet calorie and energy needs, provide satisfactory levels of protein for adults. Supplementation by milk, egg, meat, fish or oilseeds is desirable for children and lactating and pregnant mothers. In the absence of adequate fats and cereals intake to meet energy needs, proteins are utilized away leading to symptoms of protein malnutrition. The optimal and inexpensive way to curb protein malnutrition is to increase energy intake through cereals.

Pulses production has been somewhat neglected in the country and this has led to high prices. Agricultural research has to concentrate on increased yields of all varieties of pulses. Attention has to be given to dry land farming and mixed cropping.

Indian oilseeds are abundant sources of protein. However they are valued only for their oil content. In an oilseed containing nearly equal amounts of oil and protein, oil provides ten to fifteen times revenue compared to protein. In USA, soybean is cultivated mainly for its protein used in animal feeds and oil is a by-product. Indian processing of oilseeds, provides an oil cake which is not useful for human consumption. Indian groundnut cake is contaminated with aflatoxin and is no longer accepted in developed countries as animal feed. Cotton seed cake has high gossypol, that is considered toxic which may restrict male fertility. Mustard cake contains sulphur compounds which are toxic. Oilseed harvesting, drying, storage and processing should be rapidly modernized to obtain high quality oil and cake which can be used for human consumption and in animal feeds.

Milk and dairy products

Milk has a special place in Indian dietary. It has been given a place of pride and large quantities are consumed by the affluent in many forms as liquid, additive to tea and coffee, as dahi, buttermilk and as sweets. Milk is important for infants, children and in pregnancy and lactation especially for vegetarians. It is not essential for adults. Milk is not an important element of food in Japan, South East Asia, Africa or South America. Milk is a highly expensive source of calories, fat and protein in comparison with cereals, vegetable oils, pulses, egg, fish or meat. Yet milk is a very convenient and attractive food item compared to others listed. The demand is growing inspite of its high cost in family budgets.

Cattle in India are important as sources of draught power in ploughing and transport in rural areas and as provider of milk. The meat is not accepted. As mechanization in agriculture and transports increases, the male animal is no longer valued. Male buffalo calves in some states are culled as there is no demand for them. This situation will undoubtedly increase with time. It may be necessary to adopt early sex determination in pregnancy and abort the unwanted embryo. It may also be possible to fractionate sperm and use artificial insemination for obtaining very high proportion of female offspring.

Dairying and cattle rearing were based largely on open field grazing. As pasture lands get converted to farming for food, dairy cattle have to be stall fed, with compounded feeds increasing costs. Milk prices are bound to rise sharply in such conditions. As developed countries lower subsidies and reduce dairy output, cheap imports costs India from surpluses abroad may not be possible. It is urgently necessary to make an estimate of future dairy product prices. Milk should be made available to those who need it most. The poor get very little now in rural or urban areas. Dairying is a major source of employment and income and should be promoted but the products should reach children, pregnant and lactating mothers preferentially. Child and mother care systems should ensure such directed consumption.

Fish

Fish are important sources of protein, fat and minerals. Whereas agriculture and food production from land thrive through supply of water, energy, fertilizers and agrochemicals, there is very low level of support for fisheries. Fish do not need inputs of energy, fertilizers or chemicals. While there are excellent schemes for procurement of cereals, oilseeds and milk by Government, fishermen do not get guaranteed offtake and prices. The potential for freshwater and marine fish catch and production is very high and yet it is much neglected. Fisheries should be compared with food in government organization and management. Fish are the most abundant and potentially cheaper sources of food. Fish production, and distribution should be supported substantially in the same way as agriculture or dairying. Fishing can provide high employment and excellent nutrition.

Egg and poultry

Poultry farming is now a major industry and much valued. It is highly efficient and modern due to the entry of large private sector companies in supply of high breed chicks, poultry feeds and vaccines to farmers including many educated sophisticated ones. This area will clearly grow and contribute to natural nutrition and therefore should receive support. Many by-products of agriculture, animal husbandry, sericulture and forestry are used in feed formulations making it a highly competitive modern industry. Poultry do consume cereals somewhat in competition with human needs but this is not a serious drawback.

Meat

Meat is a valued item of food. Unlike in other countries, beef and pork are not accepted widely in India. Hence meat consumption is based on goats, sheep and chicken. Meat remains an expensive item, catering to the better-placed sections. It is not essential for nutrition if protein is available from cereals, milk, egg and fish. There are dangers of overgrazing by sheep and goats and ecological damage. These aspects need much greater in-depth study.

Planning for nutrition

The present processes of planning of agriculture and food do not have adequate inputs from needs of nutrition. Nutrition and food intake are intimately connected with costs, prices and incomes. Lack of nutrition leads to poor health and even mortality. This is a collossal waste. Whereas health and medicare are natural priorities with large government investments, nutrition is not receiving priority attention to the same extent. Investments in nutrition studies, surveys, education, research and application of knowledge would lead to very large natural savings apart from reduction of suffering and distress.

Nutrition and food planning should receive much greater emphasis. It is necessary to formulate and publish a National Nutritional Policy approved by the cabinet. The policy and measures for implementation should be subjects of debate and services attention by Parliament and State Assemblies. There should be a major section in the Five Year Plan document devoted to nutrition. The systems for monitoring nutrition should be substantially increased and intensified. There should be annual reports on the state of nutrition in India, containing details at district and state levels. Information on infant and female mortality, women–men ratios at different age groups, incidence of nutritional disorders and insufficiencies, special problems, of the young and the aged should be available from such reports along with analysis of availability of various components of food and their prices. Agricultural planning and food production should be derived from nutritional requirements. Most countries in South East Asia as well as China and Japan have made great strides in the last four decades in improving nutritional status.

It may be desirable to highlight importance of nutrition through constitution of a cabinet committee on food and nutrition. It would be desirable to form a National Commission on Nutrition to analyse various aspects of policy and report to government making recommendations for action.

India has excellent scientists and institutions concerned with research and education in nutrition. They have made outstanding contributions that are internationally recognized. The National Institute of Nutrition, the Departments like Food and Nutrition Board in the Department of Food and Colleges devoted to Nutrition and Home Science, the Nutrition Society of India, the Nutrition Foundation of India as well as many devoted personnel in child and mother care programmes are rendering extraordinarily valuable services. All those have to be co-ordinated through a strong representative government body with representation at high level from agriculture, food, fisheries, health, finance, planning and industry and presided over by a member of the Council of Ministers. Corresponding organizations have to be developed in the states. These will ensure quick improvements in nutritional status in true abolition of poverty and in attainment of health for all most economically and permanently.

Biochemical genetic divergence in three carangids from the Andaman Sea

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Genetic divergence and phylogenetic relationships among *Decapterus russelli, Selaroides leptolepis* and *Selar crumenophthalmus* were investigated by examining the electrophoretic patterns of seven enzymes, sarcoplasmic proteins and haemoglobins. The allele frequencies of 15 loci were estimated to calculate the genetic distances (*D*). The three carangid species were clearly divided into two groups at a *D* value of 1.72.

THE technique of starch gel electrophoresis of enzymes with specific staining for the activity in the gel, the so-called zymogram method developed by Hunter and Markert[1], is useful in many research applications. Screening studies and comparing a relatively large number of enzymes among a variety of tissues and organisms, are finding increasing use in research on population genetics, taxonomy, etc.[2] Such molecular variation is known to be genetically controlled and codominant[3] and on the whole only slightly affected by environmental disturbances[4].

Cumulative comparisons among loci between taxonomic groups can be summarized by a variety of methods into indices of similarity or conversely, genetic distance[5]. Genetic distance (*D*) is a measure of the number of allelic substitutions per locus that have occurred during separate evolution of two populations or species (which is detected roughly as differences in electrophoretic mobility of the corresponding enzymes). The basis of the measure is a so-called 'normalized identity'[6] which expresses the probability that a randomly chosen allele from each of two different populations will be identical relative to the probability that two randomly chosen alleles from the same population will be identical.

This paper describes an electrophoretic investigation into species relationships and levels of genetic distance in three members of the carangid family. The carangid fishes are widely distributed in the temperate and tropical seas around the world and occur along the east and west coasts of India supporting fisheries almost round the year[7].

Methods

Three carangid species—*Decapterus russelli* (Ruppell), *Selaroides leptolepis* (Cuv) and *Selar crumenopthalmus* (Bloch)—were collected from Aberdeen jetty, Port Blair, Andaman, during the 41st cruise of *ORV Sagar Kanya* in April/May 1988. The specimens were kept frozen until tested.

The skeletal muscles, heart and eyes were dissected from individual specimens. The cell—lysate obtained by freezing and thawing was subjected to electrophoresis for phenotypic analysis. Starch gel electrophoresis was carried out by the procedure reported earlier[5,8]. Two buffer systems were used: Tris-citric acid (T-C) pH 8.0 and citric acid-aminopropylmorpholine (C-APM) pH 6.0 (ref. 9).

The list of enzymes, tissue-specificity and loci are given in Table 1. When multiple loci was coded for an

Table 1. List of enzymes examined, loci identified and tissue assayed.

Enzyme	Locus	Buffer	Tissue assayed
α-Glycerophosphate dehydrogenase (α-Gpd)	α-Gpd	C-APM	Skeletal muscle
Lactate dehydrogenase (LDH)	Ldh-1	C-APM	Eye
	Ldh-2	C-APM	Heart
	Ldh-3	C-APM	Skeletal muscle
Malate dehydrogenase (MDH)	Mdh-1	C-APM	Skeletal muscle
	Mdh-2	C-APM	Heart, skeletal muscle
Fumarate hydratase (FM)	Fm	T-C	Skeletal muscle
Isocitrate dehydrogenase (IDH)	Idh	T-C	Skeletal muscle, heart
Malic enzyme (ME)	Me-1	T-C	Skeletal muscle
	Me-2	T-C	Heart, skeletal muscle
Creatine kinase (CK)	Ck	C-APM	Skeletal muscle
Sarcoplasmic protein (SP)	Sp-1	C-APM	Skeletal muscle
	Sp-2	C-APM	Skeletal muscle
Haemoglobin (Hem)	Hem-1	T-C	Heart
	Hem-2	T-C	Heart

enzyme, the locus with the most anodal migration was designated one, the next as two, and so on. Allele frequencies at each locus (i.e. the banding position of isozymes on the same gel) in the three species were calculated by a simple gene counting method assuming that a protein with the same mobility was controlled by the same allele even in different species, and that variations within species were controlled by two or more codominant alleles[10]. From the gene frequency data thus obtained, the genetic similarity (I) and genetic distance (D) along with standard error (SE) were calculated between every pair of the species compared. The Nei measures[11] ($D = -\log_e I$, and $SE = [(1-I)/(Ins)]^{1/2}$ were used where ns is the number of proteins examined. Nei defined the genetic similarity (I) or the normalized identity of genes between the jth and kth taxa, I_{jk} as:

$$I_{jk} = \frac{\sum_i q_{ij} q_{ik}}{(\sum_i q_{ij}^2 \cdot \sum_i q_{ik}^2)^{1/2}},$$

where q_{ij} and q_{ik} are the frequencies of the ith allele at a locus in the jth and kth taxa, respectively, and the averages are over all the gene loci examined. Nei[12] proposed a formula for estimating the phylogenetic divergence time (t years) from D i.e.: $t = 5 \times 10^6\ D$. The above estimations of D and t are based on the assumption that the amino-acid substitution rate is constant among different proteins. The dendrogram was drawn by the unweighted pair-group method (UPGMA)[13].

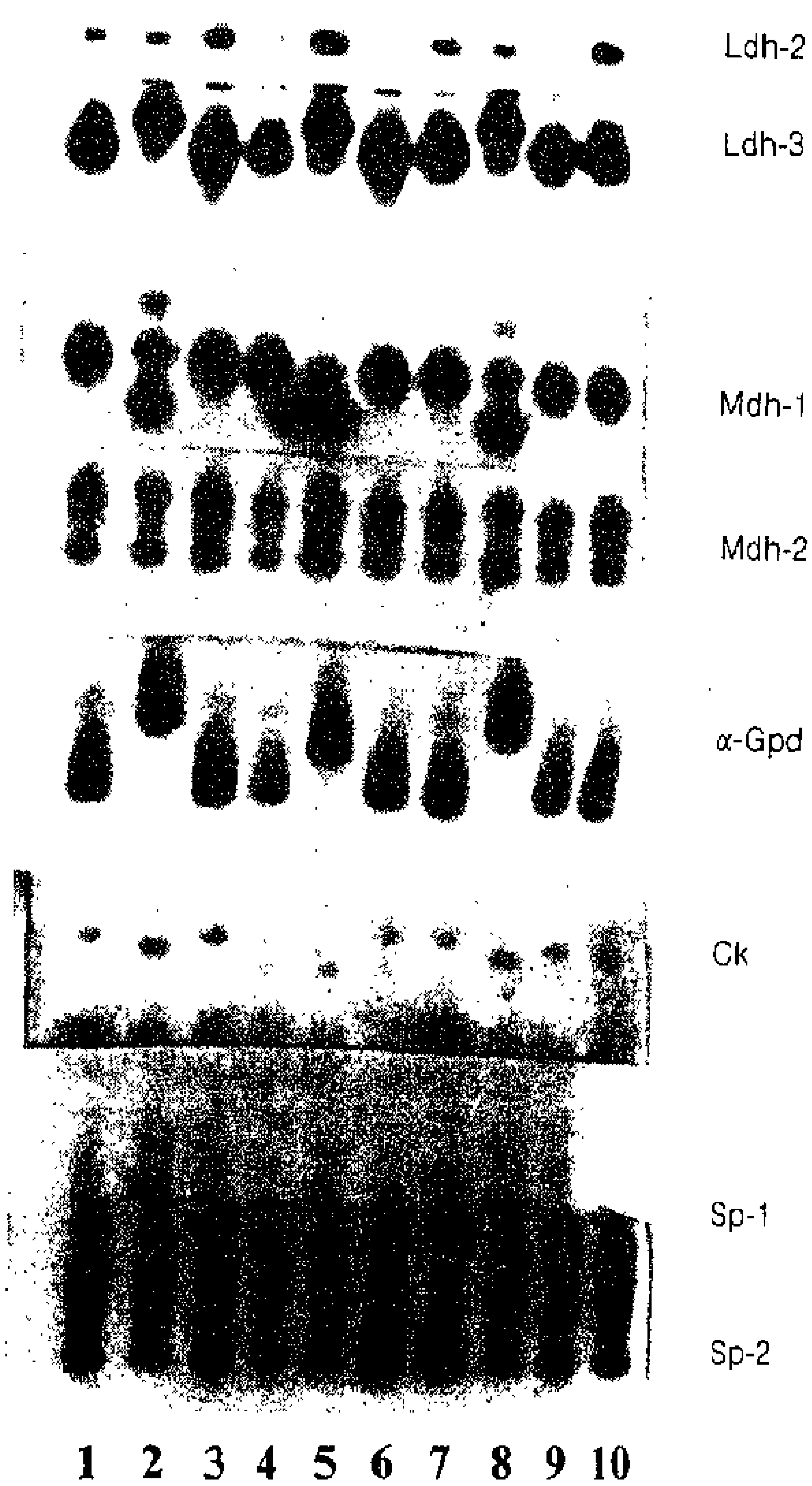

Figure 1. A comparison of isozymes of the carangid species. Nos. 1, 3, 4, 6, 7, 9 and 10—*D. russelli*; nos. 2 and 8—*S. leptolepis*; No. 5—*S. crumenophthalmus*.

Results

Figure 1 shows a comparison of the electrophorograms of isozymes among *D. russelli* (nos. 1, 3, 4, 6, 7, 9 and 10); *S. leptolepis* (nos. 2 and 8) and *S. crumenopthalmus* (no. 5). The patterns clearly showed similarities and differences among the genera in the positions of the homopolymeric band for each isozyme locus. The electrophoretic pattern of seven enzymes, sarcoplasmic proteins and haemoglobins enabled identification of 15 separate loci (Table 1). These stable and clear isozymes, in all the three species, were used as genetic markers. The system of nomenclature to designate the electrophoretically-detected loci and alleles was adopted from Allendorf and Utter[2]. Table 2 shows the alleles and allele frequencies at each of the 15 loci for the three carangid species. Allelic variants were designated according to their relative electrophoretic mobility. The most common allele was designated 100 and the others were given numbers that indicate their mobility relative to that of the common allele. Cathodal systems were similarly designated but given a negative sign. Almost all the loci were monomorphic and fixed in an allele. When the allele frequencies were compared between every two species, a large number of divergent loci were found in more distantly related species pairs.

To estimate the degree of genetic divergence among the three species, the value of D along with SE was calculated[11] between every pair of species using the allele frequencies shown in Table 2. The D value became zero when the allele frequencies of the two species compared were completely identical, and infinite when the allele frequencies of the two species compared were completely divergent, (i.e. they do not share any common allele[11]). Matrices of Nei's genetic distance between pairs of the three species given in Table 3 show that the amount of genetic divergence between *S. leptolepis* and *S. crumenopthalmus* is about 27% $[= 0.470/(1/2)(2.066 + 1.373)]$ of that between these two species and *D. russelli* using the genetic distance values. These distances can be converted into the divergence time (Table 3). Nei's genetic distance measurements