**Table 1.** Composition of total lipids, nonsaponifiables, hydrocarbons and sterols of body flesh and hepatopancreas of *P. monodon*

| Components | Body flesh | Hepatopancreas |
|---|---|---|
| Total lipids [a] | 1.53 | 17.9 |
| Nonsaponifiables [b] | 40 2 | 13 9 |
| Hydrocarbons [b] | 3 9 | 3.7 |
| Sterols [c] | Trace | Trace |

[a] Expressed as % w/w of wet tissue.
[b] Expressed as % w/w of total lipids.
[c] Trace quantities, below 1.0%.

**Table 2.** Fatty acid compositions of hepatopancreas and body flesh of *Penaeus monodon*

| Components [a, b, c] | Hepatopancreas [d] | Body flesh [d] |
|---|---|---|
| 13 iso | 0.73 | 0.50 |
| 14:0 | 5.16 | 1.35 |
| 15:0 | 1.88 | 0 88 |
| 15:1 | – | 0.82 |
| 16:0 | 28.37 | 18.93 |
| 16:1 ω9 | 7.72 | 2.70 |
| 16:2 ω9 | – | 1.62 |
| 17:1 | 1.05 | 1.41 |
| 18.0 | 6.37 | 12.75 |
| 18:1 ω9 | 17.61 | 14.22 |
| 18.2 ω6 | 6.52 | 6.71 |
| 20:0 | 0 90 | 0.50 |
| 18:3 ω3 | 4.79 | 2.77 |
| 18:4 ω6 | 0.74 | 0.20 |
| 18:4 ω3 | 1.06 | 0.88 |
| 20:3 ω6 | 1.06 | 0 88 |
| 20:4 ω6 | 5.05 | 12.97 |
| 22:2 ω6 | 2.95 | 0.39 |
| 20:5 ω3 | 4.96 | 10.44 |
| 24.0 | – | 0 46 |
| 22:4 ω6 | 0.79 | 2.03 |
| 22:4 ω3 | 0.68 | 1.18 |
| 22.5 ω6 | 0 37 | 1.13 |
| 22.6 ω3 | 1.23 | 4 03 |

[a] Short hand notation implies chain length· number of the double bonds.
[b] The ω-values indicate methyl end chain from centre of the double bond furthest removed from carboxyl end.
[c] The data shown are mean of three experiments that are within ± 5% for most of the components.
[d] Values expressed as % w/w of total fatty acids.

the saturated fatty acids, the highest level was of palmitic acid (28.4%) in the hepatopancreas but the acid was 19% in the body flesh. Among the unsaturated fatty acids, the major component was oleic acid (17.6%) in the hepatopancreas and it was 24.2% in the body flesh. EPA, the major bioactive fatty acid, was about 5% in the hepatopancreas and 10.4% in the body flesh. Of the other polyenoic acid, mention could be made of DHA, which was only 1.2% in the hepatopancreas, against 4% in the body flesh.

Omega-3 fatty acids, the principal building blocks of marine fish oils, have a number of health-enhancing properties[13]. These fatty acids, especially the EPA, in the diet reduce concentrations of cholesterol and triglycerides of the plasma by lowering the rate of synthesis of low density lipoprotein and very low density lipoprotein, which are carriers of triglycerides and cholesterol[14], by the liver and vascular tissues. Thus, it is suggested that adult patients with circulatory and other symptoms can be treated medically if EPA is taken regularly in fish-oil capsule form and various heart diseases can be prevented[15, 16]. Similar studies with DHA indicate that it is effective in skin disorders, relieves inflammatory conditions, aids brain development and also forms a good part of the retina of the eye[17].


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# Development of marked basophilia in the liver of *Heteropneustes fossilis* by some selected chemicals

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**Picric acid, a-nitrophenol and furadan were ineffective in producing any change in the liver of**

**_Heteropneustes fossilis_, whereas Urethane, 2-AAF and carbaryl induced marked basophilia in the liver, indicating that these cells are undergoing tumourigenic process.**

DURING our studies on tumour promotors and carcinogens present in our environment[1–5], it was found that pricking works as a strong tumour-promoting stimulus in the liver of *Heteropneustes fossilis*, as evident from the development of marked basophilia[6], which is a precondition for hepatocellular carcinoma formation[7]. This effect is similar to basophilia formation in the liver of this fish following initiation with DMBA and promotion with croton oil[8]. Six-month-old fish (weighing 16 g, 6.5 cm in length) were maintained in separate water tanks – having fresh water supply – in six groups of 20 each and given a supplementary diet[9]. Observations were recorded after three weeks.

Fish from group 1 were allowed to remain in a water tank containing a specified quantity of picric acid, while those in groups 2 and 3 were maintained separately in water tanks containing specified amounts of urethane and α-nitrophenol. The fish in groups 4 and 5 were maintained in tanks containing known concentrations of 2-acetylaminofluorene (2-AAF) and furadan, while those in group 6 were kept in a water tank containing a fixed concentration of methyl carbamate-1-naphthol (carbaryl) (Table 1). The fish were maintained in tanks for eight weeks, after which the experiments were terminated by immersing the fish in cold water. The fish were then sacrificed for histopathological examination. Their livers were fixed in Bouin's solution and paraffin sections (0 5 µm thick) of these organs were stained by Heidenheim's iron hematoxylene and eosin[10].

During histopathological investigations, picric acid, α-nitrophenol and furadan were found ineffective in introducing any marked cellular change in the liver of *H. fossilis*, whereas in the case of urethane, 2-AAF and carbaryl the liver of fish exhibited marked hyperplasia, thickening of cell walls, loss of cytoplasm and vacuolization, followed by a marked displacement of the nucleus, to the extent that it became eccentric with

**Table 1.** Carcinogenicity of some chemicals tested in the liver of *H fossilis* (duration of experiment, 8 weeks)

| Chemical | Concentration in water (ppm) | Number of fish/survival | Histopathological changes in liver |
|---|---|---|---|
| Picric acid | 0 2 | 20/19 | Cellular structures normal |
| Urethane | 0 001 | 20/19 | Hyperplasia, loss of cytoplasm,displacement of nucleus, basophilia, high degree of mitosis (see text) |
| α-Nitrophenol | 0 001 | 20/20 | Cellular structures normal |
| 2-Acetylamino-fluorene (2-AAF) | 0 0002 | 20/20 | Hyperplasia, loss of cytoplasm, displacement of nucleus, high degree of mitosis (see text) basophilia |
| Furadan | 0 0001 | 20/19 | Cellular structures normal |
| Methyl carbamate 1-naphthol (carbaryl) | 0 0002 | 20/20 | Hyperplasia, loss of cytoplasm, displacement of nucleus, high degree of mitosis, basophilia (see text) |

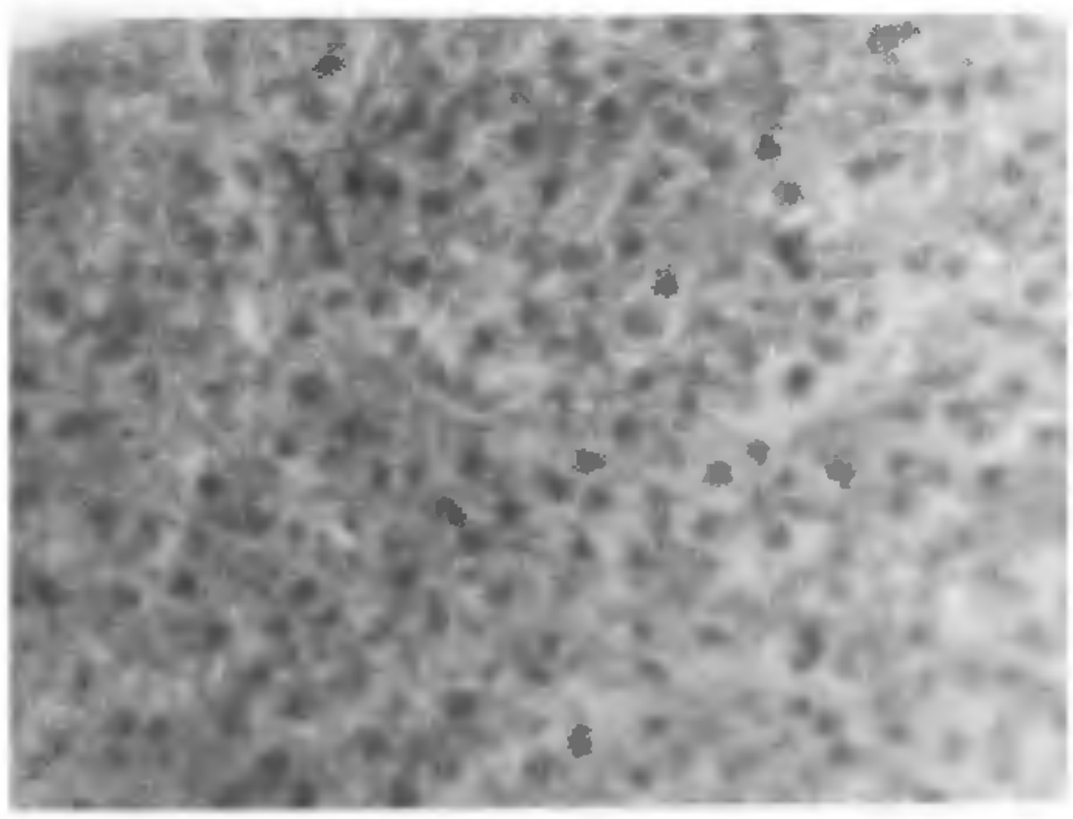

**Figure 1.** Photomicrograph of the liver of *H fossilis* (400 ×), showing normal structures

**Figure 2.** Photomicrograph of the liver of *H fossilis* treated with urethane, showing changes in the liver (400 ×) structure

a high degree of mitosis, followed by well-marked basophilia[8] of the cells (Figures 1 and 2).

Urethane, a well-known multipotential carcinogen in mice, can act as an initiator and promotor of carcinogenesis[11–13] and has been found to exhibit strong carcinogenic effect in the liver of this fish. Similarly, 2-AAF – the first pesticide synthesized, exhibiting carcinogenicity and initiation potential in mammals[14–16] – was found to initiate the formation of strong basophilia coupled with other cellular changes in the liver of this fish, thus extending its carcinogenic domain to fish as well. Similarly, carbaryl, which exhibits carcinogenicity in mammals[17], has been shown to cause cellular changes along with strong basophilia in the liver of *H. fossilis*.

It is thus evident that urethane, 2-AAF and carbaryl exhibit basophilia in the liver of this fish, indicating that liver cells undergo a tumourigenic process, leading eventually to hepatocellular carcinoma formation[7, 18].


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# *In vitro* selection for high-temperature tolerance in cultured shoot explants of *Pinus caribaea* Morelet

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**Selection of tolerant plants is the first step towards the production of plants adapted for growth in stressed environments. An attempt was made to select heat stress tolerant *Pinus caribaea* via tissue culture from explants originating from four provenances. The explant performance was evaluated using data on explant height and extent of leaf necrosis. The population structure of provenances was markedly altered by selection pressure imposed by high temperature. At 35°C, variations in growth were significant between explants within a provenance but not between provenances. At 37°C, variation in growth became significant between provenances also. This variation in performance of provenance explants may be attributed to the native temperature range experienced by a provenance. An improvement in explant performance at 37°C was also observed in those provenances which had been pre-conditioned at 35°C over unconditioned controls.**

TEMPERATURE is an important environmental factor determining in part the geographical distribution of plants. The optimal temperature for growth and the range over which it occurs varies between species and genotypes of the same species. A plant's habitat is generally determined by temperature and when ambient temperature is higher than that of the plant's natural range, heat injury is more likely to occur[1].

Tissue culture, largely callus and cell suspension cultures, have been initiated in several angiosperm species for resistance against cold[2], minerals[3], frost[4], salt[5]. The use of tissue culture technique for high temperature tolerance[6, 7] is important because even marginally changed tolerance limits are likely to be reflected in an increased species range in managed ecosystems. Previously Bedi[8] established that 35°C was a supra-optimal temperature for the growth of *P. caribaea in vitro*. Explants grown at this temperature showed a poor rate of survival and those which survived showed a significantly lower growth rate than those grown at 25 or 30°C. This investigation seeks to determine the existing variation in tolerance to high temperature and to select tolerant material at the provenance and clonal level, depending upon the extent of diversity in the population.

Shoot explants were obtained from seedlings raised under glasshouse conditions. Seeds from five diverse