Table 1. Segregation pattern of monoecious and andromonoecious sex forms in F_2 and BC-1 generations of bottle-gourd

Name of sample	Number of seeds sown	Number of plants obtained	Number of monoecious plants	Number of andromono-ecious plants	Observed ratio	χ^2 value	Probability
F_2 generation							
Sample 1	250	238	173	65	2.66:1	0.68	0.3–0.5
Sample 2	250	244	186	58	3.21:1	0.20	0.5–0.7
BC-1 generation							
Sample 1	250	232	121	111	1.09:1	0.43	0.5–0.7
Sample 2	250	235	109	126	1:1.16	1.23	0.2–0.3

F_2 and BC-1 generations were grown during summer 1994. For this purpose, two random samples of 250 seeds each for F_2 and BC-1 were separately taken from four good fruits and sown in four well-prepared plots.

Regarding exomorphological features, observation over the years reveal that andromonoecious sex is accompanied by certain peculiarities. Whereas the staminate flowers of Andromon-6 are similar to normal monoecious, the hermaphrodite flowers show a few variant features compared to normal female flowers. The variant features are: long corolla, 3.5–4.5 cm compared to 2.5–3.5 cm in normal (Figure 1 *b*, *c*); well developed anthers encircling full grown stigma (Figure 1 *d*) and oval ovary (Figure 1*d*) that develops into a drum-shaped fruit sporting 12 light grooves (Figure 1*f*) not yet reported in any normal form. The fruit bears prominent blossom scar and the majority of mature fruits contain a large number (400–700) of white/brown small empty non-viable seeds with underdeveloped seed coats. A few fruits bear 1–25 normal viable seeds. The full grown fruits are only about 25 cm in length and about 45 cm in circumference.

The expression of sex form, flower and fruit morphology and seed characteristics in F_1 generation show complete dominance of monoecious sex habit over andromonoecious sex, normal size corolla over large size corolla, long fruit shape over drum-shaped oval fruit, small blossom scar over large blossom scar and normal seed development over abnormal seed development.

The segregating patterns of the two sex forms in F_2 and BC-1 generations are given in Table 1. The data shown in the table suggest the possible existence of monogenic segregation ratio of 3:1 in F_2 generation and 1:1 in the BC-1 generation. The χ^2 values calculated assuming the above ratio show that differences in the observed and expected ratios are insignificant.

Thus, monoecious versus andromonoecious sex forms in bottlegourd follow monogenic inheritance. Similar inheritance pattern for the given sex forms has earlier been reported by Rosa[4] in watermelon. However, the other peculiar characteristics, such as oval ovary, large corolla, drum-shaped grooved fruits with big blossom scar, and abnormal seed development noticed in Andromon-6, appear to be linked with andromonoecious sex that are inherited consecutively. The linkage of round fruit shape with andromonoecious sex in watermelon has also been reported by Rosa[4] and Poole and Grimball[8] with cross-over values observed by the latter.

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Radioecological aspects of the Kaveri River environment

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We present here the results of investigations carried out in the Kaveri River Ecosystem on the background gamma radiation levels and distribution of certain radionuclides such as ^{210}Po, ^{210}Pb, ^{226}Ra and ^{228}Ra in water, sediment and biota. The ambient gamma radiation level ranged from 5 to 27 μR/h and it decreased with increasing distance from the river. Among the radionuclides tested, ^{210}Po registered the highest level of accumulation. The general accumu-

lative ability of organisms follows the increasing order: fish < prawn < molluscans < plankton. The aquatic organisms registered higher uptake of ^{210}Po and a lower tendency in the uptake of ^{210}Pb, ^{226}Ra and ^{228}Ra. Thus, the fishing community as compared to others appears to be subjected to relatively higher exposure of gamma radiations from twin exposure sources: (i) by residing near a river and (ii) uptake of higher ^{210}Po concentrations through aquatic food sources.

THE biosphere of this earth is constantly bathed in a sea of radiation[1]. Both radioactivity and ionizing radiation associated with it have existed on earth long before life emerged. We are surrounded by radioactivity[2]. Of the three ionizing radiations of primary ecological concern (alpha, beta and gamma), alpha and beta-emitting radionuclides are classified as 'internal emitters' because their effect is likely to be greatest when absorbed, ingested or otherwise deposited in or near living tissues. Conversely, radioactive substances that are primarily gamma emitters are classified as 'external emitters' since they are penetrating and can produce their effect without being ingested[3]. The interaction between humans and the environment has resulted in variations in the quality and quantity of the background ionizing radiation to which a human being is exposed. Studies on natural radioactivity in a freshwater system offers considerable scope for understanding the mechanism of radioactive transport to man through the food chain.

River Kaveri is one of the perennial rivers of South India and the longest river in the state of Tamil Nadu. The river after coursing through Karnataka state, passes through Salem, Dharmapuri, Tanjore, Tiruchirappalli and South Arcot Districts of Tamil Nadu serving as the primary source of water supply for agricultural, industrial and domestic activities. A scientific study on the natural radiation status of the Kaveri river has not hitherto been attempted. Considering the importance of knowledge on the background radiation level, a study was undertaken to evaluate the significance of natural radiation levels in the stretch of river Kaveri from Karur to Grand Anicut (95 km) together with specific investigations on the levels of radionuclides accumulated in environmental matrices.

To investigate the extent of background gamma radiation in the environment, detailed radiation surveys over an extended stretch of the river and villages situated in proximity of the river were systematically conducted using a calibrated SM 141 D ECIL Scintillometer. A 95-km river stretch from Karur to Grand Anicut was surveyed along the banks of the river at a height of 1 m above the ground. Similar surveys were also carried out in villages well away (0.5 km) from the river. The observed range of gamma radiation levels in the river tracts and some adjoining villages is given in Table 1. The survey data resulting from these detailed investigations clearly show a reasonably wide natural radiation background ranging from 7 to 27 μR/h prevailing over the riverine sediments. It was also observed during the survey that the gamma radiation level over the river sediments showed somewhat irregular and discontinuous radiation profile. This irregularity in the distribution of gamma radiation could also be attributed to the moisture content of the banks since water inhibits the release of radioactivity. These survey data were helpful in establishing the existence of natural radiation background regime in the environment of River Kaveri. Although a wide range of radiation levels (5–27 μR/h) were observed for the entire area, the higher frequency was however found to be around 15 μR/h. In contrast, the villages away from the river tended to display fairly lower radiation levels ranging from 8 to 12 μR/h (mean: 9 μR/h). The data on radiation levels of sediments from river banks, villages closer to the banks and villages away from bank were subjected to an analysis of variance. The differences between these sampling stations were found to be significant ($P < 0.1$ level). From the study, it may be said that the population residing permanently near the riverine areas are placed at a relatively higher exposure level compared with farmers and others living away from the river. The observed gamma radiation exposures in the Kaveri River environment are comparable to the ambient gamma radiation exposure along the west coast from Mangalore to Karwar in Karnataka[4] (3–16 μR/h) and far less than the ambient gamma exposure rates of Kalpakkam coastal area[5] (10–400 μR/h), indicating a low background radiation in the area, perhaps typical of a riverine ecosystem and

Table 1. Ambient gamma exposure rates in the Kaveri River environment

Location	Range (μR/h)	Mean ± SD (μR/h)
(i) *River sediment*		
Karur	15–20	16 ± 2
Mayanur	10–27	18 ± 7
Upper Anicut	10–27	18 ± 8
Coleroon	7–25	15 ± 7
Grand Anicut	10–27	16 ± 6
(ii) *Villages closer to river*		
Karur	12–18	15 ± 3
Mayanur	10–24	16 ± 6
Upper Anicut	9–25	15 ± 6
Coleroon	7–22	12 ± 5
Grand Anicut	8–25	15 ± 7
(iii) *Interior villages away from river*		
Karur	10–15	12 ± 2*
Mayanur	8–10	8 ± 1*
Upper Anicut	5–10	8 ± 3*
Coleroon	7–11	9 ± 2*
Grand Anicut	8–12	10 ± 2*

*$P < 0.1$.

Table 2. Natural radioactivity in environmental components

Sample		^{210}Po	^{210}Pb	^{226}Ra	^{228}Ra
		Bq/kg fresh			
Water	Range	0.77–2.3	1.8–3.5	0.8–1.1	4.5–7.7
	Mean	1.3 ± 0.6 (mBq/l)	2.5 ± 0.7 (mBq/l)	0.9 ± 0.1 (mBq/l)	6.2 ± 1.5 (mBq/l)
Sediment	Range	16.4–30.3	11.2–18.5	4.7–7.0	10.3–22.3
	Mean	24.5 ± 6.5	15.5 ± 3.9	5.8 ± 1.1	15.6 ± 5.3
Plankton	Range	18.9–56.6	4.8–9.3	ND–2.7	ND–3.6
	Mean	38.5 ± 17.9	7.6 ± 2.7	1.5 ± 0.6	2.5 ± 1.1
Aquatic weed					
Floating	Range	6.7–11.9	0.6–1.1	0.2–0.8	0.3–1.7
	Mean	9.6 ± 2.6	0.8 ± 0.2	0.6 ± 0.3	0.9 ± 0.4
Rooted	Range	3.3–9.4	0.3–0.8	BDL–0.1	0.3–0.8
	Mean	6.7 ± 2.9	0.5 ± 0.2	0.1 ± 0.02	0.6 ± 0.3
Crustaceans					
Muscle	Range	3.6–18.3	0.4–0.8	BDL–0.3	0.6–1.0
	Mean	11.1 ± 7.2	0.6 ± 0.2	0.2 ± 0.1	0.8 ± 0.2
Exoskeleton	Range	3.0–20.8	0.8–1.6	0.8–3.8	1.5–5.8
	Mean	12.1 ± 8.7	1.2 ± 0.4	2.6 ± 1.4	3.6 ± 2..2
Molluscans					
Soft tissues	Range	32.5–145.7	0.2–1.0	0.2–0.4	0.3–1.0
	Mean	92.1 ± 52.6	0.6 ± 04	0.3 ± 0.1	0.6 ± 0.3
Shell	Range	1.6–4.5	2.8–8.8	1.0–2.8	1.8–4.3
	Mean	2.6 ± 1.0	5.9 ± 2.8	2.0 ± 0.9	3.0 ± 1.2
Fish					
Muscle	Range	1.8–8.0	0.2–0.3	BDL–0.4	ND–0.8
	Mean	4.8 ± 3.2	0.3 ± 0.04	0.3 ± 0.1	0.6 ± 0.2
Bone	Range	0.5–6.8	0.7–2.0	1.4–3.0	1.4–4.9
	Mean	3.7 ± 2.8	1.3 ± 0.7	2.4 ± 0.6	3.1 ± 1.8

ND–not detected.
BDL–below detection limit.

suggesting no abnormal radiation dose received therefrom by the resident public in the neighbourhood.

Radium-226, Lead-210 and Polonium-210 of the Uranium-238 series are responsible for major fraction of the dose received by humans from naturally-occurring internal emitters. Radium-228 of the Thorium-232 series is a beta emitter and is similar to ^{226}Ra in toxic behaviour and therefore has considerable significance in environmental radioactivity studies, so also it contributes significantly to the background radiation by decaying to thoron plus series of short-lived daughters. To obtain comprehensive information on the distribution and bioaccumulation of radioactive nuclides and to establish the radioecological status of River Kaveri, measurement of radionuclides of uranium series such as ^{210}Po, ^{210}Pb and ^{226}Ra and those of thorium series such as ^{228}Ra was made in water, sediment and biota such as plankton, weed, prawn, mollusca and fish following the method of Iyengar *et al.*[6,7] and the results are given in Table 2. The biological samples such as prawns, molluscans and fishes were allowed to depurate in filtered river water for 24 h and washed in water to remove sand and other detritus materials, owing to high radionuclide association with silt/undigested food materials, before the commencement of experimental procedure. However, this procedure could not be applied to plankton samples. Hence, contribution of activity from silicates could not be ruled out. The analyses are described briefly:

- ^{210}Po by electrochemical deposition on a silver planchette and subsequent alpha counting.
- ^{210}Pb by allowing equilibrium growth of ^{210}Bi ($T_{1/2}$ = 5 days) and separation on $BiPO_4$ and counting in a low beta counter.
- ^{226}Ra by emanometry.
- ^{228}Ra by allowing equilibrium growth of its daughter ^{228}Ac ($T_{1/2}$ = 6.1 h) and separation of the latter on LaF_3 and counting in a low beta counter.

The data show that the living system accumulated the radionuclides to a level distinctly higher than the ambient level, the plants and animals of Kaveri River maintained varying degrees of concentration of the four radionuclides and ^{210}Po displayed maximum accumulation. High accumulations of ^{210}Po relative to other nuclides are seen in all the organisms under study. From the data in Table 2, significant intake of ^{210}Po among fish/shellfish-eating population may be anticipated due to relatively more ^{210}Po levels in the organisms, particularly in the edible parts of the muscle. Conversely, higher concentrations of ^{210}Pb, ^{226}Ra and ^{228}Ra are evident significantly in the shell. The muscle of prawn and fish are also sites of accumulation of ^{210}Pb, ^{226}Ra and ^{228}Ra as they are for ^{210}Po, but their levels are relatively much lower. The higher concentration of ^{210}Pb, ^{226}Ra and ^{228}Ra in shells and bones of aquatic organisms may be linked to their capacity to replace calcium. The concentration factors (CFs) for ^{210}Po are in the range of 10^3–10^4 with the fishes displaying low levels. The CFs of ^{210}Pb, ^{226}Ra and ^{228}Ra in comparison to ^{210}Po in the same organism are generally found to be less by a factor of 10 or even 100 in some cases and ranged from 10 to 10^3. The results of ^{210}Po, ^{210}Pb, ^{226}Ra and ^{228}Ra accumulation in some of the environmental matrices reported here are higher than the concentrations reported in certain other normal background radiation areas[8,9].

Another interesting observation was the higher concentration of these radionuclides in the abiotic and biotic components of impounded water rather than in a running water environment. This could be due to the settlement of radionuclide-rich silt and organic matter and interaction of the biotic components with the sediment and higher biological production of an impounded water body. Higher concentrations of ^{210}Po and ^{210}Pb in the environment indicate higher inputs from the atmosphere and land run off of these radionuclides, since the main source of ^{210}Po and ^{210}Pb entering the environment is the exhalation of ^{222}Rn from the ground and its subsequent decay in the atmosphere. This results in ^{210}Po and ^{210}Pb deposition on the earth's surface and higher concentrations of ^{228}Ra radionuclide in water and sediment indicating higher thorium-bearing minerals in soil/or weather rock. Gamma spectrometry of the primordial radionuclides indicated a higher level of ^{232}Th activity (45 Bq/kg) than ^{238}U activity (15 Bq/kg) in Kaveri River sediment.

This study has established the level of background radiation in Kaveri River environment. The extensive studies covering the natural radiation aspects in the area have become evident for the possible external and internal exposure of the local population. The data presented here indicate that the nuclides contribute a substantial fraction of the total environmental dose to fauna.

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Significance of the first record of nautiloid from the Upper Cretaceous Bagh Group of rocks

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The significance of the first record of an eutrephoceratid nautiloid in the Upper Cretaceous Bagh Group is evaluated here. Since nautiloids are truly oceanic in habit, their rarity is perhaps due to deep inland nature of the Bagh sea.

THE Upper Cretaceous Bagh Group, represented by shallow marine carbonates[1], is overlain by the Lameta Group or Deccan Trap and underlain by the Nimar Group or the Precambrian Crystallines. The outcrops of these rocks, although disconnected, show a parallel alignment to the course of the river Narmada and are concentrated in its northern flank (Figure 1). It is generally accepted that the Narmada–Son trend (WNW–ESE) is a tectonic lineament and represents a mid-continental rift from the Precambrian times[2], being associated with the Karoo rift system[3]. It has been reactivated many a time during the Phanerozoic, including the Upper Cretaceous, and is still active. The marine Bagh Group of carbonates were deposited in this narrow belt of inland sea bound by the rift complex and represent an aulacogen[3].