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Journals : Bunt, A. H., Lund, R, H. and Lund, J.S. (1994) : Retrograde axonal transport of the albino rat retina. Brain. Res. 72 : 215-228.

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Seed Coat Anatomy of Some Indian Dicotyledonous Taxa

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Abstract

The anatomical characteristics of seed coat of 32 Indian dicotyledonous taxa have been invesitgated. The microscopic structures provide critical details which help in distinguishing the taxa. The distinctive features of the seed coat lies in the position and structure of the main mechanical layer. These characters can be of value in systematic elucidation of various taxa.

Introduction

The structure of the seed coat of angiosperms is the characteristic of a family in general, and is, therefore, of taxonomic value (10,17). Takhtajan (14) pointed out that even for the phylogenetic correlations between families and genera, the structure of the seed coat ("Spermoderm") might be important. Corner (4,5) drew attention to the value of the structure of the seed coat in the taxonomy of the Leguminosae. Fahn (7) commented on the structure and nature of testa of some seeds from different families. He mentioned that the surface of the seeds of different species may have diagnostic features, which are used in classification. Hairs, ribs, folds, spines or hooks usually develop from the epidermis of the testa alone, but there are instances in which subepidermal cells take part in their formation.

In an earlier attempt, seed coat anatomy of 22 taxa of the Leguminosae was investigated (11). This study revealed that the seed coat, in general, is composed of outer epidermal palisade layer, usually with a light line, followed by a hypodermal layer of hour-glass cells and well-developed or reduced parenchymatous mesophyll. In addition to Leguminous seeds, some non-leguminous seeds have been studied by an array of workers

(1,2,3,8,9,12,13,15,16,17) from different genera and families. The present work is an addition to different taxa in that direction.

Materials and Methods

The seed materials of 32 taxa were collected and treated in this investigation for study following Paria et al. (11). The seed coat of the taxa has been described with reference to its thickness, the characters of testa, tegmen, etc.

Results

Description of seed coat : Seeds vary much in form, size, colour and arillar investmant within a single large and manifold families. It is is the mictroscopic structure of the seed coat which supplied the critical detail and even such manifold families have a basic microscopic character (5). The distinctive feature of the seed coat lie in the position and structure of the main mechanical layer.

<u>Polyalthia longifolia</u> (Sonn.) Thw. (ANNONACEAE)
Seed coat : 217.8±14.97 µm thick. Testa hard, thick : Outer epidermis (3.96 ±1.39 µm) composed of short longitudinally elongated brown cells. Mesophyll (169.29±4.88 µm) divided into several outer layers of longitudinal fibres and an inner layer of several transverse or oblique fibres, lignified as the mechanical protection of the seed. Tegmen (44.55 ± 8.7 µm) eventually crushed with oil cells.

<u>Calophyllum inophyllim</u> Linn. (CLUSIACEAR GUTTEFERAE)
Seed coat : 541.57±29.42 µm thick. Testa hard, thick : Outer epidermise (21.78 ±4.97 µm) composed of a single layer of small, thin-walled cells with dark contents, slightly crushed. Mesophyll (519.79±24.46 µm) woody, as an outer layer of several cells thick, composed of row of cells, elongated almost perpendicularly to the surace, but variously curved inwards, with much thickened, pitted and lignified walls. Inner mesophyll arenchymatous, thin-walled, with dark glairy contents forming network through the tissue. Inner epidermis unspecialised and eventually crushed.

<u>Hopea odorata</u> Roxb. (DIPTEROCARPACEAR (DIPTEROCARPEAE))
Seed coat : 238.47±100.31 µm thick. Testa unspecialised and crushed. Tegmen hard, thick : Outer epidermis dark brown, crushed and traversed by unicellular hairs. Mesophyll thick-walled, crushed and traversed by large elongated mucilage canals. Inner epidermis composed of small cuboid cells with brownish deposition.

Shorea robusta Gaertn. f. (DIPTEROCARPACEAE)
Seed coat : 378.88± 24.4 µm thick. Testa unspecialised and crushed. Tegmen hard thick : Outer epidermis (16.17 ± 1.87 µm) as a short palisade of dark brown cells, elongated radially with thick walls. Mesophyll (111.87±4.78 µm) with thick-walled cells, mucilage canals and banded parenchyma. Inner epidermis composed of small cuboid cells with brownish walls.

Bombax ceiba Linn. (MALVACEAE)
Seed coat : 154.77 ± 18.13 µm thick. Testa hard, crushed (33.99 ±10.21 µm). Cells thick-walled, compactly arranged and provided with brown contents. Tegmen : The palisade cells (84.48 ± 4.45x7.26 ±1.39 µm) of outer epidermis radially elongated without linea lucida. Some heavy dark contents present in the outer part of palisade layer. The inner epidermal cells (36.3± 3.46 µm) thick walled, transversely elongated, and provided with dark brown contents.

Thespesia populnea (Linn.) Soland ex Correa (MALVACEAE)
Seed coat : 401.27±34.16 µm thick. Testa hard, thick (109.96±15.14 µm), outer epidermis provided with simple baloon-like trichomes and composed of thick-walled cells with brown contents. The cells of inner epidermis transparent and compactly arranged. Tegmen : The palisade cells (257.04 ±11.66 µm x 8.25 ±1.74 µm) radially elongated, and traversed by a narrow uniform layer of deposition in the outermost part of palisade. Due to deposition, the palisade apparently in two layers. The inner epidermal cells (34.27 ± 7.37 µm) crushed, compact and with brown content.

Ambroma augusta (Linn.) Linn. f. (STERCULIACEAE)
Seed coat : 335.28±10.82 µm thick. Testa hard, thin (25.41± 2.23 µm), the cells of the outer epidermis thick-walled and with brownish substances. Inner epidermal cells compactly arranged. Tegmen : The palisade cells (248.83 ± 2.89 µm x 10.23 ± 2.43 µm) of outer epidermis tubular, radially elongated. Linea lucida present and sometimes traversed by deposition. Further deposition present in two rows above the middle part of palisade layer. The inner epidermis detached.

Sterculia foetida Linn. (STERCULIACEAE)
Seed coat : 651.55 ± 27.12 µm thick. Testa hard, thick (70-100 µm in immature seed). In mature seeds this layer crushed and ultimately dried up except the tegmic part. Tegmen : The palisade cells (494.09 ± 21.5 µm x 10.89 ± 2.23 µm) of outer epidermis radially elongated, obliquely pitted, and without linea lucida. Some dark contents present at the outer part of palisade layer. Mesphyll thick (157.41 ± 5.62 µm), dark brown layer of elongated cells with slightly thickened walls.

<u>Aegle marmelos</u> (Linn.) Correa (RUTACEAE)
Seed coat : 405.98 ± 145.87 μm thick hard, thick : Outer epidermis (34.32 ± 4.72 μm) composed of short longitudinally elongated, pitted, lignified cells, often with undulated facets developing fascicles of closely septate hairs. Mesophyll thin-walled, the outermost layer often with crystals. Inner epidermis with a crystal in each cell. Tegmen (28.05 ± 9.24 μm) thickened, crushed. Inner epidermis present as a layer of small tannin-cells.

<u>Citrus medica</u> Linn. (RUTACEAE)
Seed coat : 331.3 ± 40.54 μm thick. Testa hard, thick : The irregular lobulate processes appearing as palisade (115.67 ± 20.69 μm x 14.25 ± 1.7 μm) and forming the outer epidermis composed of thick-walled, and lignified cells with slight musilaginous external layer. Mesophyll (104.24 ± 8.58 μm) cells transversely elongated, thin-walled, aerenchymatous, transparent. Inner epidermis (17.16± 4.34 μm) thick-walled, deep brown with deposition. Inner hypodermis (94.22± 6.92 μm) thin-walled, transparent, transversely elongated cells

<u>Hesperethusa crenulata</u> (Roxb.) Roem. (RUTACEAE)
Seed coat : 222.05±48.9 μm thick. Testa hard, thick : Outer epidermis (54.45 ± 27.62 μm) as palisade of cells, thick-walled, lignified, undulate, with irregular short processes to the exterior; many of these cella elongating into fascicles of hairs. Mesophyll (104.24 ± 17.87 μm) with many cells containing crystals, and almost colourless. Inner epidermis thick-walled, brown pitted and lignified.

<u>Ochna artopurpurea</u> DC. (OCHNACEAE)
Seed coat : 94.05 ± 7.83 μm thick. Testa hard, thin : Outer epidermis (33.99 ± 2.72 μm) present as a brown membrane and uniformly fragmented. Inner epidermis (60.06 ± 5.11 μm) deep brown, crushed, with cells unspecialised. In this layer, endotestal polygonal crystals present.

<u>Azadirachta indica</u> Juss. (MELIACEAE)
Seed coat : 450.77 ± 123.86 μm thick. Testa hard, thick : Outer epidermis (31.02 ± 9.49 μm) thick-walled. Mesophyll (322.73 ± 105.41 μm) composed of several layers of compact, flattened, thin-walled cells with scattered crystals. Inner epidermis unspecialised. Tegmen (92.02 ± 8.96 μm) : Outer epidermis as a compact layer of longitudinal fibres. Mesophyll consisting of several layers of large thin-walled cells, rather crushed; inner epidermis also crushed. Perisperm (147.08 ± 15.13 μm) persistent, of several cells thick and traversed by globular dark depositions.

<u>Melia azedarach</u> Linn. (MELIACEAE)
Seed coat : 89.1 ± 13.74 µm thick. Testa hard, thick : Outer epidermis (20.8 ± 9.69 µm) composed of thin-walled yellowish cells, with polygonal facets, not lignified. Inner epidermis as a layer of small cells with brown, lignified wall. Tegment (27.72 ± 9.99 µm) thick : Outer epidermis present as a compact layer of longitudinal lignified fibres. Mesophyll of thin-walled cells, eventually crushed. Inner epidermis as a layer of short radially elongated cells with brown walls.

<u>Swietenia mahagoni</u> (Linn.) Jacq. (MELIACEAE)
Seed coat : 984.79 ± 58.89 µm thick. Testa thick and soft : Outer epidermis (29.04 ± 4.34 µm) present as a layer of cells mostly with pitted walls. Mesophyll ((856.8 ± 36.25 µm) composed of large subglobose cells, arenchymatous. Inner epidermis as a layer of small, deep brown, elongated crushed cells with few crystals. Tegmen (103.95 ± 18.3 µm) several cells-thick : Outer epidermis (24.42 ± 5.2 µm) present as a compact layer of signified fibres. Mesophyll (58.74 ± 10.87 µm) several cells thick with outer, short longitudinally elongated sclerotic cells; the inner cells thin-walled, enlarged, not lignified. Inner epidermis (20.79 ± 2.23 µm) as a layer of oval or elongated cells.

<u>Zizyphys mauritiana</u> Lam. (RHAMNACEAR RHAMNEAE)
Seed coat : 278.46± 29.53 µm thick. Testa firm, thick : Outer epidermis (23.76 ± 4.34 µm) as a compct short palisade of prismatic cells, lignified with reduced kumen. Mesophyll (254.70± 25.19 µm) with large cells, eventually crushed and some cells with lignified walls. Inner epidermis with small cells, unspecialized. Tegmen eventually crushed.

<u>Euphorbia longan</u> (Lour.) Steudel (SAPINDACEAE)
Seed coat : 279.89 ± 22.53 µm thick. Testa hard thick : Outer epidermis present as a palisade (30.03 ± 2.89 µm x 9.9 ± 3.31 µm) with thick brown walls. Mesophyll broad (249.85 ± 19.64 µm), composed of elongated, compact, brown cells, slightly crushed. Tegmen crushed and unspecialized.

<u>Litchi chinensis</u> Sonn. (SAPINDACEAE)
Seed coat : 300.94 ± 30.82 µm thick. Testa hard, thick : Outer epidermis narrow with cuticle. Palisade (21.78 ± 2.78 µm x 4.95 ± 1.74 µm) with radially elongated, thick-walled wide cells. Mesophyll (252.76 ± 23.37 µm) composed of elongated cells in several layers and more or less crushed in lower part. Inner epidermis unspecialised and crushed. Tegmen (26.4 ± 4.67 µm) apparently crushed and unspcecialized.

<u>Anacardium occidentale</u> Linn. (ANACARDIACEAE)
Seed coat : 2507.27± 65.37 µm thick. Testa hard, thick : Palisade in two rows;

outer palisade cells long (220.77 ± 12.78 µm x 25.74 ± 2.6 µm), thick-walled,without linea lucida and traversed by some dark contents. Inner palisade cells short, (49.5 ± 2.69 µm x 9.57 ± 1.87 µm) comparatively thin-walled, more or less transparent, without linea lucida. Hour-glass cells in two short outer rows (34.32 ± 6.26 µm x 23.76 ± 5.11 µm and 30.69 ± 4.13 µm x 9.57 ± 2.89 µm), thick-walled, upper one more transparent than lower one. Mesophyll exceedingly thick (2171.99 ± 39.51 µm), broad, slightly crushed, thick-walled, contiguous cells with brown contents.

<u>Parinarium nitidum</u> Hook. f. (ROSACEAE)
Seed coat : 536.56 ± 61.6 thick. Testa hard, thick, with sclerotic mesotesta. Outer epidermis unspecialized. Mesophyll (488.38 ± 51.62 µm) with short longitudinally elongated sclerotic cells intermingled with almost colourless cells in several layers and crushed. Tegmen (48.18 ± 9.98 µm) more or less crushed and unspecialised.

<u>Barringtonia acutangula</u> (Linn.) Gaertn. (MYRTACEAE)
Seed coat : 1641.21± 289.41 µm thick. Testa thick, hard : Outer epidermis composed of short cells with undulate facets, thick and lignified. Mesophyll thin-walled, arenchymatous with extensive sclerotic cells with thickening. Inner epidermis unspecialized. Tegmen unspecialized.

<u>Euggenia jambolana</u> Lam. var. <u>Jamblana</u> (MYRTACEAE)
Seed coat : 370.36 ± 55.1 µm thick. Testa thick : Outer epidermis (50.59 ± 16.69 µm) composed of thick-walled cells, becoming crushed with sclerotic tissue. Mesophyll (319.87 ± 38.2 µm) thin-walled cells. Inner epidermis unspecialised. Tegmen unspecialized and crushed.

<u>Gustavia augusta</u> Linn. (MYRTACEAE)
Seed coat : 250.8 ±21.32 µm thick. Testa thick, hard : Outer epidermis (67.65 ± 4.47 µm) composed of short cells with undulate facets, the outer wall thickened, lignified, dark brown as a tough layer. Mesophyll (111.87 ± 4.78 µm) thin-walled, with scattered sclerotic cells, eventually more or less crushed. Inner epidermis unspecialized, crushed and with dark brown deposition. Tegmen (71.28 ± 12.07 µm) unspecialized and crushed.

<u>Madhuca indica</u> Gmelin (Sapotaceae)
Seed coat : 283.47 ± 40.11 µm thick. Testa hard, thick : Outer epidermis (27.06 ± 6.38 µm) composed of small thick-walled cells of variable length and traversed by dark depositions. Outer hypodermis (209.88 ±8.83 µm) of outer part consisting of subglobose thick-walled cells and inner part consisting of thick-walled elongated cells. Few crystals present in this layer. Inner epidermis (46.53 ± 24.91 µm) brown, thick-walled, crushed and with unspecialized cells.

<u>Mimusops elengi</u> Linn. (SAPOTACEAE)
Seed coat : 577.05 ± 22.67 µm thick. Testa hard, thick : Outer epidermis present (20.13 ± 3.63 µm) as a single-celled layer with stellate cells and slight cuticle. Inner epidermis very much thick, (556.92 ± 19.04 µm) many-celled, exhibited by two types of cells, i.e. the outer part with polygonal stellate cells having central brown content; the inner part consisting of transversely elongated substellate cells with deep brown central deposition. Tegmen not specialized and crushed.

<u>Diospyros discolor</u> Willd. (EBENACEAE)
Seed coat : 373.56 ± 38.38 µm thick. Testa hard, thick : Outer epidermis (33.33 ± 3.28 µm) with thick-walled, interrupted cells. Palisade (194.7 ± 6.22 µm x 30.03 ± 2.43 µm) composed of radially elongated, wide cells, with more or less thickened walls. Inner epidermis single-celled, thick-walled and elongated. Mesophyll (53.13 ± 18.69 µm) thin-walled, crushed, some cells with crystals. Tegmen (92.4 ± 10.08 µm) thin-walled, crushed and unspecialized.

<u>Nyctanthes arbor-tristis</u> Linn. (OLEACEAE)
Seed coat : 167.94 ± 31.99 µm thick. Testa soft, thin : Outer epidermis composed of (23.76 ± 2.09 µm) elongated brown cells, with thickened wall and easily detachable from testa. Mesophyll (56.46 ± 4.87 µm) transparent, compressed, thin-walled and with slight deposition. Inner epidermis crushed.

<u>Spathodea campanulata</u> beauv. (BIGNONIACEAE)
Seed coat : 75.72 ± 21.85 µm thick. Testa thin soft : Outer epidermis (16.32 ± 5.67 µm) composed of elongated crushed cells. Mesophyll (59.4 ± 16.17 µm) also crushed, and arranged in rows in upper part; in lower part, the cells radially elongated. Both the parts traversed by few crystals and many star-shaped structures. Inner epidermis composed of elongated brown cells with thickened walls.

<u>Tecoma stans</u> (Linn.) H.B. & K. (BIGNONIACEAE)
Seed coat : 48.51 ± 3.83 µm thick. Testa thin and soft : Outer epidermal cells (26.4 ± 3.48 µm x 15.84 ± 3.41 µm) elongated, thick-walled and palisade-like. Mesophyll (22.11 ± 0.35 µm) sclerotic, crushed and longitudinally elongated. Inner epidermis crushed and unspecialized.

<u>Gmelina arborea</u> Roxb. (VERBENACEAE)
Seed coat : 892.5 ± 38.82 µm thick. Testa hard thick : Outer epidermis (8.58 ± 1.7 µm) present as thin-walled, elongated brownish cells. Mesophyll (883.92 ± 37.11 µm) of several layers, thick, compactly arranged. Inner epidermis crushed and unspecialized. Tegmen not specialized and crushed.

Putranjiva roxburghii Wall (EUPHORBIACEAE)
Seed coat : 851.09 ± 31 μm thick. Testa thin-walled, unspecialized. Tegmen : Outer epidermis (358.43 ± 10.54 μm) as a layer of longitudinally oblong, thick-walled, pitted cells. Mesophyll thick (492.66 ± 20.47 μm), crushed, compact, with some scattered sclerotic cells. Inner epidermis unspecialized, eventually crushed.

Artocarpus heterophyllus Lam. (URTICACEAE)
Seed coat : 349.59 ± 32.63 μm thick. Testa thin and easily peeling off : Outer epidermis (25.41 ± 4.41 μm) transparent, persistent as cuboid cells with rectangular facets and slightly thickened walls. Mesophyll (252.76 ± 16.56 μm) thin-walled, parenchymatous. Tegmen (71.4 ± 11.66 μm) crushed, unspecialized with slight brown deposition.

Discussion

A survey of the seed coat anatomy reveals the diversity indifferent taxa (16) which may be discussed under two broad categories. In the first one, the testa is predominent e.g. mostly leguminous (11) and a few non-leguminous taxa. In the second, both testa and tegmen are distinct, e.g. mostly non leguminous taxa. In the first category, the seed coat may be provided with palisade in a single or rarely double layer(s); sometimes, this may be absent also. In the second category, the seed coat is characterised by well- developed testa and unspecialized tegmen or vice versa. Sometimes, both testa and tegmen may be well-developed. In addition, the seed coats of the investigated taxa are characterised by other features also.

In non-leguminous seeds, testa is characterised by palisade or palisade-like cells as outer epidermis but devoid of cuticle, light line and hour-glass cells (e.g. Citrus medica, Hesperethusa crenulata, Tecoma stans, etc.) The seed coat of Anacardium occidentale is very thick; here the palisade is differentiated into upper and lower layers. The former is composed of long cells and the latter of comparatively short cells. The major part of the seed coat is occupied by a broad mesophyll layer which is interrupted by large cavities in the middle. Between the cavities, the mesophyll tissue is projected to either sides so as to connect both the upper and lower layers. Some stomata are present in the lower palisade layer. The seed coat (250.7.27 μm) including the mesophyll (2171.99 μm) is exceedingly thick amongst all taxa studied.
In this work, some testal seeds without palisade cells are also noted. This type of seed coats exist in Calophyllum inophyllum, Nyctanthes arbor-tristis, Madhuca india, Ochna artopurpurea, Spathodea campanulata etc. In C. inophyllum, the mesophyll layer is specialised and differentiated into broad

outer woody and narrow inner aerenchymatous zones while the same in N. arbor-tristis is compressed, thin-walled and transparent. In the seed coat of Spathodea campanulata, the mesophyll layer is composed of longitudinally and radially elongated cells, being traversed by crystals and star-shaped sclereid-like structures. In Ochna artopurpurea, the outer epidermis is almost uniformly fragmented. Evidently, the above taxa bear seed coat without outer epidermal palisade cells but with well-defined mesophyll layer.

In the second category of seed coat, where both testa and tegmen layers are present, the following features may be noted.

As to the occurrence of palisade layer, it may be epidermal (e.g. Euphoria longan, Litchi chinensis, etc.), subepidermal palisade cells (Diospyros discolour) or without any palisade (e.g. Barringtonia acutangula, Gmelina arborea, Mimusops elengi, Parinarium nitidum, etc.)

In seed coat of Euphoria longan, Litchi chinensis and Zizyphys mauritiana, the major part of testa is occupied by mesophyll layer.

The seed coat of Diospyros discolor represents an elaborate distinct testa and thick-walled crushed tegmen. In the testal layer, outer epidermal cells are interrupted or detached. The hypodermal palisade cells are wider, sometimes with mucilage.

In some testa, the seed coat is provided with testa and tegmen layers but without palisade cells. Such testa reveals some remarkable features. In Aegle marmelos, the outer epidermis is characterised by undulate facets, developing fascicles of closely septate hairs. The uppermost part of the outer epidermis and the inner epidermis are traversed by crystals. The seed coat of Artocarpus heterophyllus is composed of cuboid cells with rectangular facets. The outer epidermis is tough, lignified with dark brown contents in Gustavia augusta and the mesophyll layer is with scattered sclerotic cells. Sclerotic mesophyll layer is also found in Barringtonia acutangula and associated with scattered xylem elements with thickening.

The seed coat of Polyalthia longifolia is represented by a fibrous testa. The mesophyll layer consists of an outer layer of longitudinal fibres and an inner layer of transverse or oblique fibres. Tegmen layer contains some oil-cells. The Annonaceae is often used as a fertile stock for the derivation of other families. Corner (5) remarked that the fibrous testa does not occur in advanced families.

In Eugenia jambolana and Gmelina arborea, the seed coats are unspecialized and not well differentiated. In Parinarium nitidum, both the testa and tegmen are crushed and the testa is exhibited by frequent sclerotic cells. In Mimusops elengi, the testa is characterised by the presence of stellate and substellate cells.

The Malvaceae and Sterculiaceae are exemplified by exotegmic testa with palisade cells but the testal layer is reduced or unspecialised. In Bombax malabarica, the outer part of the palisade layer is almost uniformly traversed by dark deposition. The cells of the inner epidermis are transversely elongated with dark-brown deposition. In the seed coat of Thespesia populnea, exotegmic palisade is available. Moreover, baloon-like trichomes are associated with the outer epidermis of testa. At present, two taxa from the sterculiaceae, namely Amroma augusta and Sterculia foetida were studied for seed coat. In both taxa, exotegmic palisade is promiment. Moreover, in Sterculia foetida the major part of tegmen is occupied by palisade cells and with oblique pitting. The mesophyll layer is dark brown in colour. In case of Ambroma augusta, the palisade cells are short and provided with deposition.

The seed of Putranjiva roxburghii is very hard but without palisade layer. Its outer epidermis is characterised by longitudinally oblong pitted cells. The mesophyll layer is compact and contains scattered sclerotic cells. The unspecialised and crushed nature of testa is evident in the seed coat of Dipterocarpaceae; here the tegmen layer is well-differentiated. In Shorea robusta, the mesophyll layer is frequently occupied by mucilage canals with banded parenchyma. The outer epidermis and mesophyll of Hopea odorata are flanked by unicellular hairs and elongated large mucilage canals respectively.

The fibrous exotegmen exists in three investigated taxa of the Meliaceae. The seed coat is differentiated into distinct testa and tegmen layers, while the palisade layer is not visible. The seed coat of Melia azedarach is distinguished by thin-walled yellowish cells with polygonal facets in outer epidermis of testa. In Swietenia mahagoni, the mesophyll of testa is composed of subglobose cells, but the same consists of several layers of compact, flattened, thin-walled cells with scattered crystals in Azadirachta indica.

The foregoing description would reveal that various anatomical features as encountered in the present taxa may be similar or dissimilar to some extent at the level of a family or genus. In certain cases, a particular character or a combination of characters may be of taxonomic value. For example, the differences in the position of palisade layer in the testa and tegmen are significant in this connection. In the leguminosae, the palisade layer is the outer epidermis of outer integument and the same is the outer epidermis of inner integument inthe Malvaceae, Sterculiaceae, etc. Thus, the anatomical structure of seed coats can be a valuable aid to taxonomy to a certain extent.

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Coastal Aquaculture and Environment in the context of West Bengal, India

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Abstract

Coast al West Bengal, India, comprising two large districts viz. 24-Parganas and Midnapore, located on the eastern and western flanks of Hooghly Estuary respectively, has an expanse of 0.82 million hectare coastal area and a coast line of 210 km. long. These areas encompass one of the highly productive and large mangrove estuarine complexy of the world. This paper discusses the potential along with the management strategies of the environment with regard to sustainable aquaculture development in this coastal area, highlighting the major adverse environmental effects of it.

Key words : Coastal aquaculture, Mangrove management, Sustainable environment.

Introduction

Aquaculture is rapid all over the world and especially in developing countries it can accord a substantial boost to total biological production. This offers advantages over other conventional methods of exploitation through controlled supervision on production, harvesting and processing of aquatic organisms. It is expected that aquaculture activities vis-a-vis production will be expanding significantly all over the world in the near future with further improvement of ecofriendly technologies and diversification. Aquaculture production in 1990 constituted approximately 15.3% of the world's fishery production (12) as compared to 14% in 1989 (11). In 1990 coastal aquaculture production amounted to approximately 7.5 million tons (12). It is well known that there is a constant interaction of aquaculture with the environment because it requires biotic resources. This interaction is further brought about through expansion of land and water areas under culture, involvement of modern technologies with the higher usuage of water, food, fertilisers and chemicals. The expansion of aquaculture and its interaction with the environment generate substantial socioeconomic benefits through increased nutrition (29). Simultaneously, there is a growing concern about adverse effects of aquaculture on the environment (27). During the last onedecade or so increasing attention has been directed towards sustainable development of coastal aquaculture where a sound ecological balance between the harvest and renewals of living resources, inputs and outputs would be maintained. The aim of this paper is to explore the possibilities of environmental management of coastal aquaculture development in West Bengal.

Coastal Environment of West Bengal

The coastal area of West Bengal extends over 0.82 million hectores and along 210 km. coastline. These diversified ecosystems chiefly comprise 2,340 km2 of the Hooghly-Matla estuarine system; 33,000 hectares of saline and 9,600 hectares of nonsaline bheries; 3 million hectares of the mangroves (19).Out of the two coastal districts of West Bengal, Midnapore district is characterised by sand dunes, long shore currents, less turbid but high saline water influence (in some areas), minor river discharge (14). The other coastal district - the South 24-Parganas is supported by the Hooghly-Matla-Mangrove-Estuarine complex of Sundrbans. The entire area is criss-crossed by a number of estuaries viz., Hooghly, Matlah, Muriganga, Saptamukhi, Thakuran, Bidyadhari etc. and their tributaries, creeks of varying depth and width forming a good number of deltaie islands (9).

Flora :

The Sundarbans mangrove forest harbours 36 true mangrove species, 28 mangrove associates and 7 oblgatory mangrove species, representing a total of 29 families and 49 genera. Based on their present status in respect to environmental stress, 8 major mangrove species require immediate conservation measures to ensure long-term sustainability of these species in the area (9). Rich algal communities remain in the mangrove forest subsystem as an epiphytic assemblage of algae living on the stems, pneumetaphores of mangrove trees and on the surface of the sediment as epibenthic form (6). Besides, a good number of algae remain in the water subsystem as phytoplankters and play a great role inthe total productivity and energy flow of the system (16,10). 48 species of bacteria isolated from decomposed litter (4) along with 184 species of fungi and 44 species of protozoa constitute a rich microbial community (8). Coastal areas of Midnapore district, once endowed with luxuriant mangrove vegetations, are now represented by scanty occurrence of about 5 well tolerant mangrove species. Besides, unlike the floral composition of Sundarbans area or nearby Orissa coast, coastal Midnapore is represented by as many as 156 species beloning to 120 genera and 55 families (32).

Fauna :

Zooplankton, an important biotic component of aquatic subsystem of Sundarbans includes copepods as principal mysidacea, sergestidae, amphipoda, cladocera, ostracoda cumacea, chaetognatha etc. (holoplankters) and polychaete larvae, nauplius, zoea, megalopa, fish larvae, etc. (meroplankters) (5). A hoard of benthic fauna (macro and meio - benthos) are the happy residents of these habitats (7,22,30,36). A total of 172 species of fish have been recorded from the Hooghly-Matlah estuarine complex of which 73 occupy the less Saline zone and 99, the higher salinity zone (18). A total of 26 species of prawns and shrimps spread over in 5 families occur in these estuarine waterbodies of Sundarbands (16). Published information on Midnapore coast are very scanty. Digha coastal areas are represented by 458 species of nektonic and benthic fauna belonging 296 genera and 19 classes (17). 94 species of molluscs have been recorded from the area (35). (31) noticed an inverse relationship between macofauna and meiofauna on the Digha coast with regard to their numerical abundance.

Physico-chemical parameters :

Rapid and distinct seasonal changes of different environmental parameters are a striking feature of coastal West Bengal. Seasons are well-defined in this estuarine system, each of about four month duration. The seasons fall under premonsoon, monsoon, and postmonsoon. The most important factor salinity gives a higher result in Midnapore district, while tidal amplitude is higher in South 24-Parganas (1,6,20).

Coastal Aquaculture of West Bengal

Coastal brackish water aquaculture in West Bengal has undergone an evolution from traditional aquaculture (bheri fisheries) to intensive monoculture through paddy cum fish culture and polyculture. The average yield of fish and prawn in the bheries of West Bengal ranges from 694 to 878 Kg./ha/yr., the estimated total production from all bheries being 25.518 t/yr. The usual yields from the paddy cum fish culture, generally practised in West Bengal, has been estimated at 825.68 Kg/ha/yr. for fish and prawns, 2.71/ha/yr. of paddy and 2718.2 kg/ha/yr. of hay, the contribution of prawn being 30% of the aquacrops. Development of new technology has ensured to increase the production of paddy to 5.5 t/ha/yr. along with 700 kg. of car per ha/yr.

(15). Polyculture of penaeid prawns with mullets (Mugil parsia, M. tade) or with other brackishwater species like Lates calcarifer is now considered as an effective alternative to the intensive or semiintensive monoculture system from both the economic and ecological points of view (24). The intensive or semiintensive one-species (Penaeus monodon) aquaculture has expanded significantly in recent years in all the maritime states in India. Again within India, West Bengal ranks first with regard to the total estimated brackish water area, (4,05,000 ha), area under culture (34,050 ha) and estimated shrimp production (16,3000 ha.) (33).

Adverse Environment Effects of Coastal Aquaculture

Like other coastal states, recent expansion of coastal aquaculture has generated several environmental as well as socio-economic problems in West Bengal (23).

Seed resource :

All the penaeid prawns and fin fishes cultivated in coastal aquaculture farms breed in their natural nursery ground along the entire coast line of West Bengal, from where their postlarvae are collected by the rural people with a shoot net (100 mesh/cm2). As collectors are interested in P.monodon seeds, they damage seeds of other fin fished posing a threat to the conservation of natural resources in particular and to the entire ecosystem in general (25).

Degradation of mangroves :

Mangrove ecosystem, one of the world's most productive ecosystems sustaining the ecological integrity and productivity of adjacent coastal waters (6), which has degraded considerably in West Bengal, needs to be protected. Larsson et al (21), through calculations suggested that a semiintensive shrimp farm needs 35-190 times larger mangrove support area of the surface area of the farm.

Nutrients enrichment :

Semiintensive shrimp farmings as practised in West Bengal release into the aquatic environment a huge amount of metabolic waste products and unconsumed food. As much as 77.5% of N and 86% of P, released from the feed (26), cause entrophication. Solid organic waste, released from the farms, settles in the sediment and impairs the functioning of benthic environment. Over use of antibiotics could lead to develop drug-resistant shrimp pathogens which, in turn, make human pathogens drug-resistant (12).

Socio economic impacts :

Disruption of coastal ecosystem due to aquaculture activities may lead to coastal erosion, horizontal and vertical seepage of saline water, transformation of multifarious usuage of coastal resources into a privately owned single purpose resources, displacement of small-scale fisherman, outbreak of diseases, development of eutrophication (2,27,28,34).

Discussion

Coastal aquaculture in all the maritime states of India will have brighter future in terms of production of food and earning of money than fresh water aquaculture (33). In West Bengal,during the last one decade, rapid expansion of one species aquaculture (P. monodon) has revealed impact of shrimp culture on the environment as well as impact of the adjoining environment on shrimp culture. This has resulted in poor production in recent years due to outbreak of disease on the one hand and environmental degradation on the other.

Coastal environment of West Bengal has advantages over other coastal states because of its possession of mangrove contributed nutriend rich water and suitable land for aquaculture development (6). Keeping this in mind and utilising the past experiences gained from several aquaculture activities as practised in West Bengal, future aquaculture operations should be geared up in such a manner which that environment and development hand-in-hand.

Barbier (3) has suggested some sustainability criteria which include increased recycling, minimal use of nonrenewable resources, maximum resource use efficiency within industrial processes exploiration of renewable resource at a rate lesser than their natural rate of ecologically safe regeneration and reduction of waste-generation level to well within the assimilative capacity of the environment. In order to achieve these objectives, an integrated apprach to coastal aquaculture seems to be acceptable because aquaculture practices involve all trophic levels. That's why, wastes from one type of cultivation can be used as resource in others (13,37).

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An Approach to Agroforestry System for small land holdings

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Abstract

Per capita cultivable land is declining very fast in India. From 0.48 ha in 1951, it is expected to go down to 0.11 ha by 2000 A.D. In West Bengal, 82.32 per cmt of the land holdings belong to the size class 0 to 2 ha. The bonafide needs of such a large group of marginal farmers need to be addressed through Agroforestry models.

This paper deals with the different aspects of Agroforestry, such as research needs, soil fertility and transfer of technology to the land user through extension service.

Introduction

Increasing human population is reducing the land holdings of the rural poor, who form a large section of India's population. From 0.48 ha. in 1951, the per capita cultivable land has declined to 0.26 ha. in 1981. It is apprehended that by the year 2000 AD it will go down to around 0.11 ha. per capita (3). In West Bengal, 82.32 of the land holdings belong to size class 0 to 2 ha, of which 39.95 percent have even less than 0.50 ha. of land (11).

The live-stock population is also on the rise. The Committee on Fodder and Grass appointed by the Government of India in 1985 estimated the availability of only 229 million tonnes of the same as against the requirement of 672 million tonnes. It has been estimated that by the end of 2000 A.D. approximately 949 million tonnes of dry fodder and 1200 tonnes of green fodder will be required to rear the cattle population of India.

Fuel wood is another bonafide requirement of the community whose supply is far less than in demand. The World Bank estimates (1987) place the total consumption of forest-based products to above 230 M.Cu.M., out of which, it is admitted, 230 M.Cu.M. comes from bushes and woody matter (2). By the year 2000 A.D. the total consumption of foresh products is expected to reach 290-300 M.Cu.M, out of which 230 M.Cu.M. will be for fuel wood alone. How much load is borne by the existing forests in terms of fuel wood is difficult to ascertain because in case of fuel wood 85 percent of supply is said to have come from unrecorded sources.

A look at the total consumption indicates that overcutting of existing forests and plantation is as high as 300 percent with the result that forests in India are shrinking by about 1.5 million ha. per year (12). This is not because of over-cutting alone butalso because of low productivity caused by various disturbances including removal of leaf litter from the forest floor, cutting bushes regularly for fuel and uncontrolled grazing by cattle in the forests. As per the State ot the World report (1991), Indian woodlands can support notmore than 39 M. Cu. M. of annual harvest. This amounts to 0.046 Cu.m. per person for both fuel wood and all forest produce.

Efforts are on through social forestry, farm forestry and Wasteland development to address to the complex problems of shortage on every front as stated above. It is true that farm forestry has been very successful in India, but this has been possible mostly with large and middle income farmers, who could readily adopt tree crops within their farming systems. The same model has not paid dividens tothe marginal farmers. As mentioned above, the farmers with small hldings have nothing to invest as capital, nor canthey afford to wait till the harvest is over, even when the planted trees grow fast with short rotations. Unless the bonafide needs i.e. food, fuel and fooder etc. of the marginal farmers are met on their own land, the existing forests will remainunder constant pressure and no amount of efforts can reverse the process of deforestation. Therefore, appropriate cropping system may be developed as agroforestry models which can take care of the needs of the community. This paper deals with the different aspects of agroforestry such as research needs, soil fertility, sustainability, training and extension.

Agroforestry

Agroforestry may be defined as a sustainable land use system where woody perennials (trees, shrubs, palms, bamboos etc.) are deliberately used on the same land management unit as agricultural crops/or animals either on the same form of spatial management or on temporal sequence (7). In simple words, it is intercropping woody plants with food and forage crops.

Agroforestry is not a new concept in Asia. Contrary to popular belief as stated by Nair (10), a sizeable percentage of the total production of most of the plantation crops is produced in small holdings. These form a significant proportion in terms of both the population they support and the area they cover. In these small holdings, the farmers usually integrate crops and animal production with perennial crops, primarily to meet their food requirements. Some of the integrated plantation crop systems include :

Cacao + Food vrops	in Ghana, Nigeria and Trindidad
integrated farming systems, (food crops + poultry), sometimes rubber :	In small holdings in Malaysia, Thailand, Nigeria, India and Shrilanka
Coffee as integrated crop in small holdings :	In East Africa, Colombia, Ivory Coast and Madagascar.
Intercropping and cattle raising with coconuts :	in India, Phillipines, Srilanka and Pacigic islands.
Cashew as a result of intercroping :	in India, Tanzania and Mozambique.

A visit to the countryside of India reveals that almost all the village households have some trees in their vicinity. These trees have been planted by the household members or were planted by their forefathers inadjacent fields or homestead land. A survey in Gujarat, India, showed that even amongst farmers who were not involved in the community forestry programme, the average number of trees owned by a family was 15. The most common species recorded were Acacia nilotica, Prosopis juliflora, neem and fruit trees, mainly mango. The trees were grown or maintained not for sale but for domestic consumption as timber, fruit, fuel wood or fodder (4).

Agroforestry Models

In many agroforestry situations, the farmer's primary objective, i.e. food production sets limits per unit of farm land. As the size of the land, the prevailing climatic condition, topography, tree species and agricultural crops are all variables, so there can not be a particular model covering all. However, arrangement of trees on farm land may be either of the following types as summarised by Vergara (13) :

1. Trees planted at field borders or farm boundaries.
2. Alternate rows of food and tree crops.
3. Alternate strips of food crops and trees.
4. Random mixture of food crops and trees.
   (Refer to Fig. 1)

Border planting (#1) is suitable when food crop needs little or no shading and is placed in the wide central open space. The trees serve as boundary markers, live fences, fire breaks or wind breaks in addition to producing wood, fodder, fruit and green manure. Alternate row arrangement (#2) may be suitable when food crops require partial shading and more organic fertilizers or green manures from litter fall (most suitable trees in this case is legume). Random mixture (# 4) may be of any form.

The alternate strip arrangement (#3) or Alley cropping allow wider gaps between tree strips and food crops that require more exposure to sunligt. Periodic prunning during the cropping season not only prevents shading but also provides green manure and/or mulch to the arable crops. Promising results have been obtained from this type of study conducted at International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria (5,14). Alley cropping concept that started in 1972 by IITA's work has produced encouraging results with leguminous plants Leucaena leucocephala and Cajanus cajan and a combination of Leucaena/maize and various combinations of noize, casava and Leucaena. Similar research works should be pursued in different agroclimatic zones to develop Agroforestry models suitable for diverse situations.

Production Priority

Agroforestry involves two or more species of plants (or plants and animals) and, therefore, has two or more outputs. The same output may be a major product in others, as is represented below :

Major Product	Secondary product
Fuel wood	Forage
Staple food	Fuel wood
Forage	Fuel wood
Perennial cash crops	Forage

[From Vergara, 1982].

Crop Combinations and Soil Fertility

Fig. 2 (13) gives a simpler and more general way of looking at agroforestry systems. It can have a series of possible combinations between agriculture (or forage) and forestry crops ranging from pure (100 percent) to various degrees of combinations in between. Closer to the agriculture end, the system places more emphasis on agricultural output and less on forestry. On the other hand, close to the forestry end, the system puts more emphasis on forestry output than on agriculture (13).

The two extremes of the Fig. 2 represent monoculture where nutriend cycling is generally less efficient causing high leaching and more loss of nutrients (output) from the cropping system. Nutrient use efficiency in agroforestry system is quite high (in between the two extremes). Deeper roots of tree component does not compete with the surface feeder agricultural crops. Additionally, the minerals from deeper layers of soild are pumped into trees and brought to the surface through leaf fall or prunning and lopping of trees. Therefore, replenishment of nutrients in upper soil layer and complementary sharing of the same below ground restrict the leaching of nutrients, resulting in little loss (output) from the agroforestry system. Further, surface water runs off and soil erosion is checked. Hence, it is apparent that agroforestry system is more beneficial economically and ecologically as well.

Orienting Agroforestry Research, Training and Extension

Research works related to farming systems and their benefits can only be useful when the findings are effectively communicated to the end users, say, small farmers or other groups of rural poor. The best way of achieving this is by conducting the research in front of their eyes (or creation of demonstration plots) so that the results could be visible and convincing. The most important constraint, which is also a ground reality, is that agroforestry requires the skill of agriculture as well as that of forestry. Forest departments are trained for growing trees, whereas the agriculture departments are trained for maximising production of arable crops. Extension services of forest department have never been effective during its over 100 years of history. Agriculture sector has certainly in edge over forestry in this regard. Sometimes it so happens that neither institutions are prepared to recognise the benefits of combining the two. The result is that the considerations that set departmental priorities seldom include the best interests of small farmers, who have little political clout (8). Even the research needed for agroforestry systems suitable to small holdings are not properly funded. According to Hocking (6), "There are specific agroforestry systems that may be adopted to poor selfom attracts the interest of researchers or the funds of research agencies. On the other hand, research intensification of agroforestry technology is well funded. This is a problem because research on intensification is biased away from the very poor, it places greater demands on resources (soil fertility, water) and so is inherently better suited to fertile sites (and the rich farmers who own them) than to marginal ones or to wastelands contrary to the rhetoric, the most likely beneficiary of this agroforestry research would be rich!"

The time has come when we must restructure our programmes for forestry training. FAO (4) observations are pertinent in this regard. Forestry training courses must be changed to include ecological and environmental subjects, economics, management and the social sciences. More attention must be paid in basic forestry courses to land use economics, rural forestry (in particular agroforestry production system, ergonomics and appropriate tools, soil conservation and protection. Opportunities for specialization in these areas should also be provided. Since extension will be the main activity of many foresters, training in educational methods and communication skills is needed. The expansion of forestry curricula in these new directions should be accompanied by review to determine the obsolete or relatively unimportant components of present forestry courses which can be deleted."

Lastly, I would like to react to the observations made from time to time by different experts that the researchers are mostly confined to their laboratories and within a limited boundary. The role of the specialists (resource persons, researchers) should equally be recognised by the economists and other social scientists and the function of each component involved indeveloping agroforestry models should not be treated in isolation, but should be seen as complementary to each other. Extension staff have to interact directly with the end users. Their function will be to assist the local people in defining their needs and to suggest plans within the limitations of the people's own resources to meet their needs. They should also indicate feasible realistic possibilities to duige people in making appropriate choices. Only then the participation of the larger poor section of the society can be ensured towards sustainable land management bringing about ecodevelopment.

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Figure 1 : Trees and crops : spatial arrangement

1. Trees along border

T	T	T	T	T	T	T	T	T	T	T	T
T	C	C	C	C	C	C	C	C	C	C	T
T	C	C	C	C	C	C	C	C	C	C	T
T	C	C	C	C	C	C	C	C	C	C	T
T	C	C	C	C	C	C	C	C	C	C	T
T	T	T	T	T	T	T	T	T	T	T	T

2. Alternative rows

T	C	T	C	T	C	T	C	T	C	T	C
T	C	T	C	T	C	T	C	T	C	T	C
T	C	T	C	T	C	T	C	T	C	T	C
T	C	T	C	T	C	T	C	T	C	T	C
T	C	T	C	T	C	T	C	T	C	T	C
T	C	T	C	T	C	T	C	T	C	T	C

3. Alternative Strips or Alley cropping

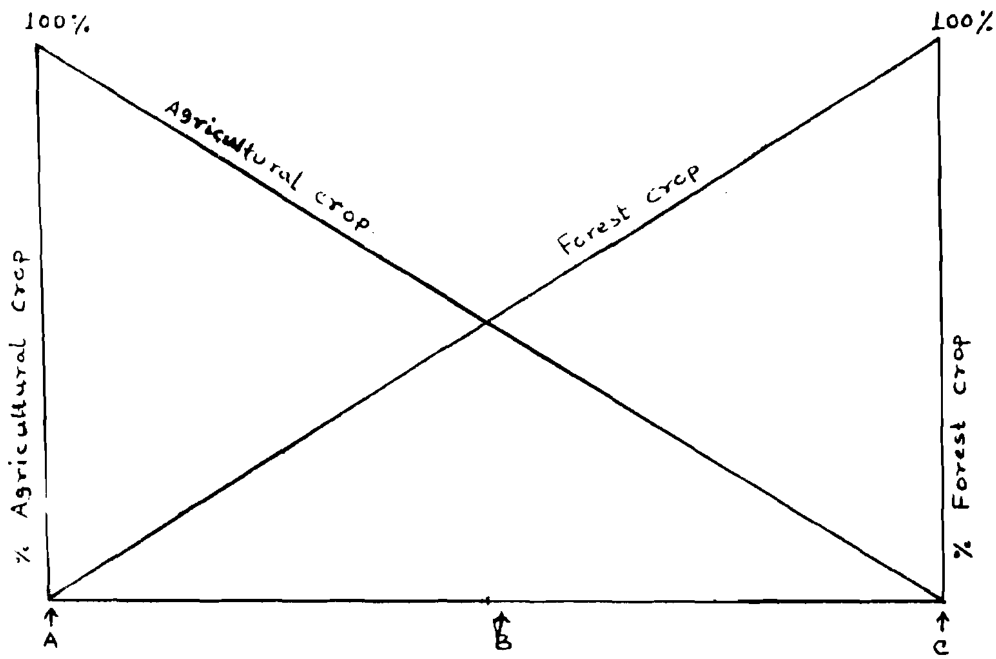
T	T	T	C	C	C	T	T	T	C	C	C
T	T	T	C	C	C	T	T	T	C	C	C
T	T	T	C	C	C	T	T	T	C	C	C
T	T	T	C	C	C	T	T	T	C	C	C
T	T	T	C	C	C	T	T	T	C	C	C
T	T	T	C	C	C	T	T	T	C	C	C

4. Random mixture

T	C	C	T	T	C	T	C	C	T	C	T
C	C	C	C	C	C	T	C	T	T	C	C
C	C	T	C	C	C	C	T	C	C	C	T
T	C	C	T	T	T	C	C	C	T	T	C
C	C	T	C	T	C	C	T	C	C	C	C
T	T	C	T	C	C	C	C	T	T	C	T
T	C	T	C	C	C	T	T	C	C	C	T

Legend : T = Tree
C = Annual food crop.

Figure : 2 : Crop combinations in agriculture - forestry continuum



A - Pure agricultural crop

AB - More agriculture than forestry

B - even mixture of agriculture and forestry products

BC - More forestry than agricultural crops.

C - Pure forestry cropping

Source : Vergara (1982).

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Effect of Lithium Chloride on DNA and RNA Content in Testis and Bidder's Organ of Toad (Bufo melanostictus)

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Abstract

DNA and RNA contents in testes and Bidder's organ were measured after injection of lithium chloride in toad. A significant diminution was noted in nuclic acid content of above sex organs after lithium chloride injection for 14 days. It is suggested that lithium may suppress the cell proliferation in above cytogenic organs, i.e. spermatogenesis in testis and formation of follicles as well as corpus luteum in Bidder's organ.

Key words : Lithium, DNA, RNA, testis, Bidder's organ.

Introduction

In psychopharmacology, among antimanic drugs, lithium chloride produces the most dramatic therapeutic improvement of manic patients (1). Beside its therapeutic importance, lithium treatment is associated with hypothyroidism (2), hyperadrenocortical activities (3) and diabetes mellitus (4). Literature survey reveals that there is a paucity of information regarding the effect of lithium chloride on the reproductive system. However, earlier reports indicate that lithium chloride inhibits testicular steroidogenesis and spermatogenesis in toad (5,6) and rat (7). DNA and RNA synthesis are associated with sprematogenesis (8). In Bufo, Bidder's organ is considered as rudimentary ovary as both corpora lutea (9) and follicles (10) are present in it. Effect of lithium chloride on DNA and RNA synthesis on testicular tissues and Bidder's organ is reported in the present work.

Materials and Methods

Bufo melanostictus, the common Indian toad, which is a seasonal breeder, was used in the present investigation. They breed between April and September. Eighty male toads, with an average body weight of 50 g were collected from their natural environment during the month of June. The animals were maintained under natural illumination and temperture (light approx. 05.00 - 18.30 hrs. 32 $\pm$ 5°C) for entire period of experiment. Animals were divided equally into two groups. All the animals were provided with food (ant eggs) and water ad libitum on alternate days. Treated group received lithium chloride at the dose of 200 µg (dissolved in 0.1 ml of water)/toad/ alternate day for 14 days. This dose and duration have been selected on the basis of our earlier study (5.6). Control group received vehicle for 14 days. Animals were killed on the 15th day. Weights of testis and Bidder's organ were taken in an electric balance. Testes as well as Bidder's organ of 4 animals were pooled in all groups for biochemical estimation of DNA and RNA.

Chemicals :-Standard DNA, RNA (Sigma, USA), Perchloric acid, KOH and sucrose (BDH) were used.

Estimation of DNA in Testis and Bidder's organ :- A 2.5% homogenate of the tissue was made in cold 0.25 M sucrose. One ml of this homogenate was used and both DNA as well as RNA were extracted by perchloric acid according to the method developed by Abalian et al (11). Quantification of testicular DNA and RNA was performed at 260 nm from standard curve.

Estimation of RNA in testis and Bidder's organ :-A 2.5% homogenate of the tissue was made for DNA estimation and quantification of RNA was performed according to the procedure of Abalian et al (11). The amount of RNA was measured from standard curve after noting the absorbancy at 260 nm by Shimadzu UV - 3100 spectrophotometer.

Results

Sex organ's weight : - Lithium treatment resulted in the diminution in the weight of testes and Bidder's organ significantly when compared to control (Table-I).

Biochemical studies :- Both testicular DNA and RNA decreased significantly in lithium treated animals. DNA and RNA contents of Bidder's organ also decreased significantly in lithium-treated animals when compared to control (Graph 1 and Figure 1).

Discussion

Spermatogenesis provides a unique system for the study of cell differentiation in higher animals. During this process, the differentiating cells exist in both diploid and haploid forms where DNA and RNA synthesis are altered in a specific sequence. DNA synthesis is known to occur only during the spermatogonia and the resting phases of the primary spermatocyte, and is terminated just before the onset of the meotic prophase (12). As the content of DNA in testis follows the spermatogenesis quantitatively (8,13), as is indicated in our previous study, it has been reported that lithium treatment produces inhibition in spermatogenesis. Diminution in DNA content in testis after lithium treatment also supports the antigonadal effect of lithium. Germ cell proliferation in testis depends on testosterone and as testosterone level is diminished in lithium treated animals (7), so low DNA content in testis may be due to inhibition in spermatogenesis or may be due to inhibition of DNA polymerase by this agent.

RNA synthesis occurs in a number of spermatogenesis cells (14). The RNA synthesis initially occurs during the leptotene stage and then increases gradually during the zygotene, pachytene, diplotene and secondary spermatocyte to reach to a maximum during the early spermatid stage (14). As RNA content in testis after lithium treatment has been decreased significantly, so it also supports te antigonadal effect of lithium.

Bidder's organ is also cytogenic organ where follicles and corpus luteum are noted (9,10). Leutinasation and follicular formation in Bidder's organ are under the control of gonadotrophins (15). As DNA and RNA content of cytogenic organ reflects the status of cell proliferation, so the low DNA and RNA content in Bidder's organ of lithium treated toads also indicates that lithium exerts inhibitory effect on follicular formation and corpus luteum formation, which is a further confirmation of our previous study (16).

In conclusion, it may be said that these results provide evidence for the first time that lithium suppresses the DNA and RNA synthesis in gonadal organs in toad. The actual mechanism of the inhibition in nucleic acid synthesis in these organs remain to be elucidated in future experiments.

Acknowledgements

The authors are thankful to Dr. Ananta Kumar Ghosh, Dept. of Biotechnology, IIT, Kharagpur, for his activd co-operation and for the use of the UV spectrophotometer (Shimadzu UV-3100). Thanks are also due to Prof. Prabhakar Sengupta, Principal, Raja N.L.Khan Women's College, Midnapore for his active encouragement and advice.

Table - 1

Effect of lithium chloride on testicular weight, Bidder's organ weight, in adult toad. [Mean± S.E. N=10].

Group	Testicular wt. (Pair) (mg%)	Bidder's organ wt. (Pair) (mg%)
Control	245 ± 11	16 ± 1.35
Treated	204 ± 10*	10 ± 1.17*

Student - t test, * significance at the level of $P<0.05$

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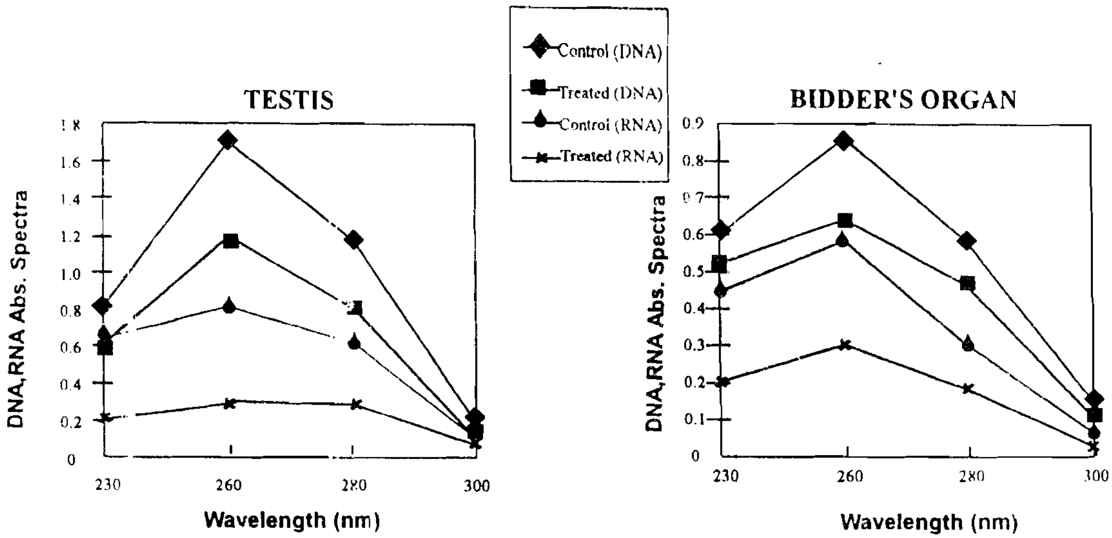

Graph - 1. Absorption Spectrum of Testicular and Bidder's Organ DNA & RNA in Lithium treated toad

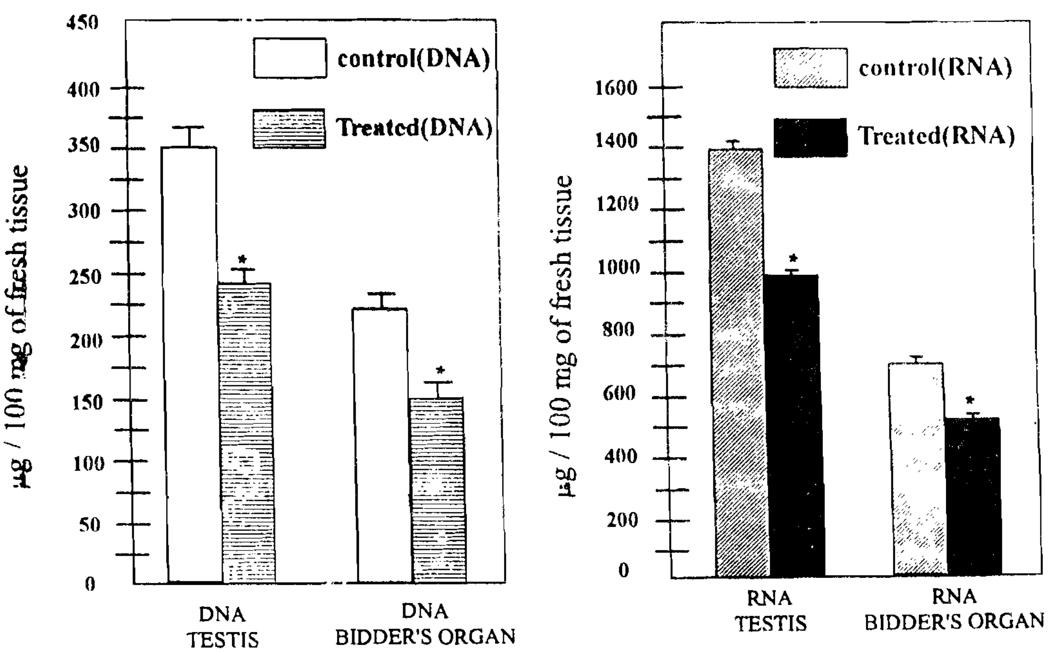

Figure - 1. DNA & RNA Content in testis and Bidder's organ after lithium chloride treat ment of adult toad (Mean ± S.E,N =10)

** Significant at the level of P<0.05.*

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Importance of Protein diet and Iron Supplementation in Bengali Female Athletes

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Abstract

Both endurance and strength-power athletes appear to require more dietary protein than the minimum reommended daily allowance. In addition, female athletes may be affected because of the possibility of a greater iron need during physical exercise. There is a positive correlation between protein and iron status in exercising female students.

The present study was undertaken to observe the importance of protein diet on endurance capacity and also on hemoglobin concentration of female athletes after supplementation of iron, Vitamin C and Folic Acid.

Eighteen female athletes, age ranging between 18-22 years, participated in an endurance exercise on a magnetic brake bicycle ergometer at 900 Kgm/min. They were divided into three groups : Group A - Control group without any supplementation, Group B - iron supplement together with Vitamin C and Folic Acid; Group C - protein food together with Vitamin C and Folic Acid. Each group had 6 subjects.

Results indicate that there was no significant change in Group A, but in Group B and Group C, the change was significant both in hemoglobin concentration and endurance capcity. Endurance time also increased more in Group C than in Group B.

These findings suggest that protein diet together with iron was more effective in the enhancement of female athletic performance.

Key words : Protein diet; Supplement of Iron, Vitamin C and Folic Acid; Endurance Capacity; Hemoglobin Concentration

Introduction

Of late, interest has centered on whether exercise alters protein metabolism and iron status and consequently, how important is supplementation of protein and iron for athletes. The much talked about problem in strenuous and prolonged exercise is "loss of iron" and protein synthesis appears to be reduced during endurance exercise.

There is convincing evidence from human studies suggesting that iron deficiency reduces physical work capacity [4]. In India, there is a classic problem in women - "the anemia", which could be related mainly to inadequate nutritional background and is caused by inadequate availability of iron, folic acid and Vitamin C [6]. It has ben observed that iron supplementation can improve physical performance [3,5].

There is a positive correlation between protein and iron status in exercising female students. Iron status improved considerably after iron and protein supplementation [2] and the percentage of protein in the diet became more influential on iron status [7].

The present study was designed to correlate hemoglobin concentration with supplementation of protein and iron together with Vitamin C and Folic acid and physical performance in athletic women.

Materials and Methods

18 female kabadi players from Sodepur Dist. Club, age ranging 18-22 years, volunteered for this study. Before three months and during the study they were known to have taken no extra iron supplementation from other sources and had regular menstrual cycle and none of these subjects had known history of any chronic cardiac and respiratory diseases.

6 subjects, randomly assigned to no supplementation, formed Group-A; 6 more subjects, randomly assigned to take iron together with Folic acid and Vitamin C supplementation, formed Group-B and the remaining 6, assigned to take protein and iron together with Folic acid and Vitamin C supplementation constituted Group-C. Iron with Vitamin C and Folic acid (120 mg ferrous sulphate, 75 mg ascorbic acid and 0.5 mg folic acid) of SIDMAK Lab. in the form of a capsule and protein (50 gm egg albumin) were given for 15 days at a stretch.

Before and after supplementation of each group, the Hb concentration was measured by cyanomethemoglobin method (Harrole et al, 1980) and each subject was allowed to do work on magnetic brake bicyle ergometer with the workloads 900 Kgm/min, and endurance time was measured till exhaustion and at the end of performance, peak and recovery heart rate were taken upto 15 min. The room temperature was between 32o-34oC and the relative humidity was about 70%.

Statistical Analysis

For small samples (N=18) from a normally distributed population, the appropriate critical ratios for testing the significance of differences between sample means are provided by Student's test. Here, a two tailed 't' test by difference method has been applied.

Results

Table 1 : Mean ± S.D. of physical characteristics of exercising female adults

Group	Age(Yrs.)	Height (cms)	Weight (Kgs)	BSA(m2)
A	19.83±1.367	151.31± 2.76	49.8 ± 4.31	1.321 ± 0.02
B	19.667±1.46667	151.117±11.101	47.56± 3.67	1.402±0.032
C	20±20	152.95± 48.81	49 ± 4.0	1.435±0.05

A = Control B = Iron + Folic Acid + Vitamin C
C = Iron + Protein Diet

Table 2 : Mean ± S.D. of Hemoglobin Concentration and Endurance time before and after 15 days supplementation

Group	Hb conc. (gm%)		Endurance time (min)	
	Before	After	Before	After
A	12.1± 0.496	12.193± 0.5776*	14.875±1.48	15.175±1.534*
B	12.15 ± 0.299	13.65±0.535**	15.966±1.687	20.516±3.429**
C	12.466±0.126	14.63±0.087**	16.78 ± 3.295	23.867±0.55**

* Not significant, ** Significant at P < 0.05, N = 18

Discussion

In this study, effects of supplementation of iron together with Folic acid and Vitamein C and protein diet on physical performance of adult athletes were studied. On analysing the data, it was seen that hemoglobin concentration and endurance time changed significantly in Groups B and C after supplementation.

It was observed that oral iron with Vitamin C and Folic acid supplementation increased significantly (P < 0.05) hemoglobin concentration in Group B from

12.15 gm % to 13.65 gm%. Supplementation of protein diet with iron, Vitamin C and Folic acid also enhanced the hemoglobin concentration level in Group C from 12.46 gm% to 14.63 gm%. But in the control group (Group A) there was no change (Table 2). There is a positive correlation between protein diet and iron status as protein supplementation improved hemoglobin concentration [7].

Iron in diet is mostly present in ferric state, which is reduced to ferous form during absorpiton. Vitamin C and glutathion and amino acid SH groups help in reduction. Protein plays an important role in iron metabolism. After absorption, the iron molecules are rapidly reconverted into ferric state, which then combines with protein (apoferritin) and forms the iron-phosphorous-protein complex, ferritin. Another transport form of iron in the plasma is transferrin, which is formed by ferris iron with β_1-iron binding globulin.

The present study reveals that, with supplementation of protein diet in Group-C, amino group of protein diet enhances the performance capacity of female athletes.

In strenuous and prolonged exercise iron is lost from the body and protein synthesis appears to be reduced during exercise. Iron is an important part of hemoglobin and myoglobin, as well as in the cytochromes of electron transport chain. The average iron intake in the country has been found to be around 5.9 mg per day as compared to the recommended 15-20 mg [1].

The iron obtained from animal food is absorbed better than the iron (non heme) obtained from vegetables. However, absorption of non-heme iron can be increased in the presence of animal protein(meat, fish) and Vitamin C. Presence of phytate in the diet decreases iron absorption.

As iron plays a crucial role in the transportation of O_2 to the tissues and mitochondrial oxidative phosphorylation; supplementation of protein improves the iron status. That's why the rate of increasing physical performance in terms of endurance time in Group-C (from 16.78±1.2 to 23.87±0.55) was better than in Group B (from 15.966±1.68 to 20.51±3.42) after supplementation, but no change was noted in the control group, i.e. in Group-A (Table-2).

As the typical Bengali diet which is mostly cereal and vegetable-based, is relatively low in animal protein and has higher phytate content, the intake and absorption of iron in these subjects may be low leading to decreased iron status.

IMPORTANCE OF PROTEIN DIET AND IRON

In the present study, supplementation of protein diet and also iron with Vitamin C and Folic acid has therefore resulted in improved iron status as Vitamin C increases the rate of iron absorption and here Folic acid plays a significant role in erythropoesis as an erythropoeting factor. This increased iron status perhaps increased the hemoglobin level, cyochrome and ferroenzyme activity and thereby enhanced endurance capacity.

From the above findings it is evident that supplementation of iron with Vitamin C and Folic acid and also protein diet has a beneficial role in better performance in exercising adult females.

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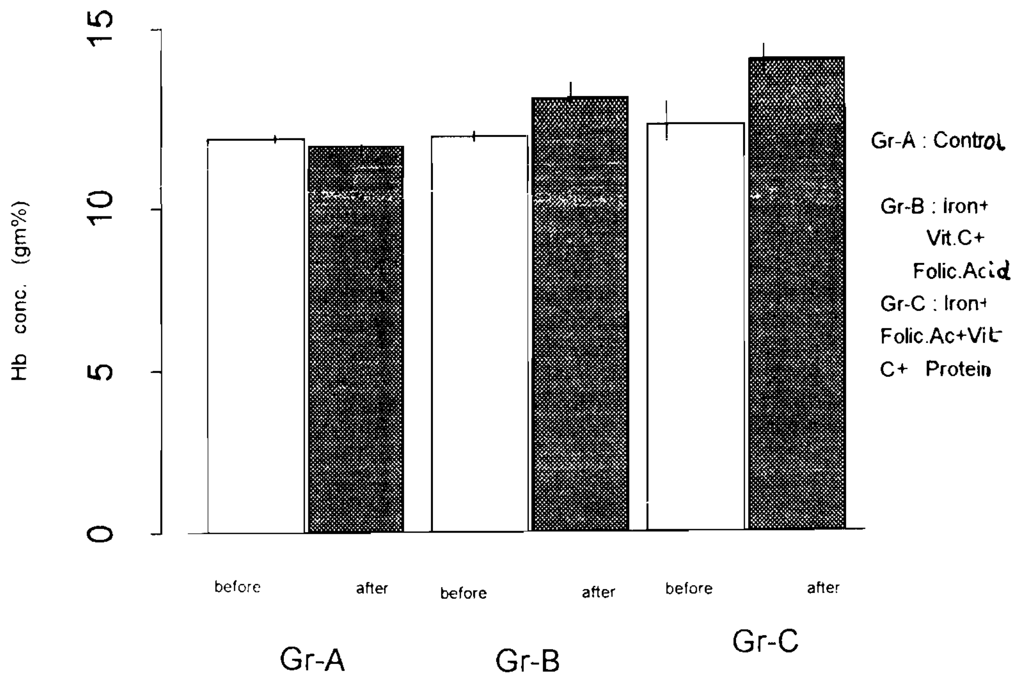

Fig.1: Mean ± S.D. of Hemoglobin concentration of female athletes before and after 15 days supplementation

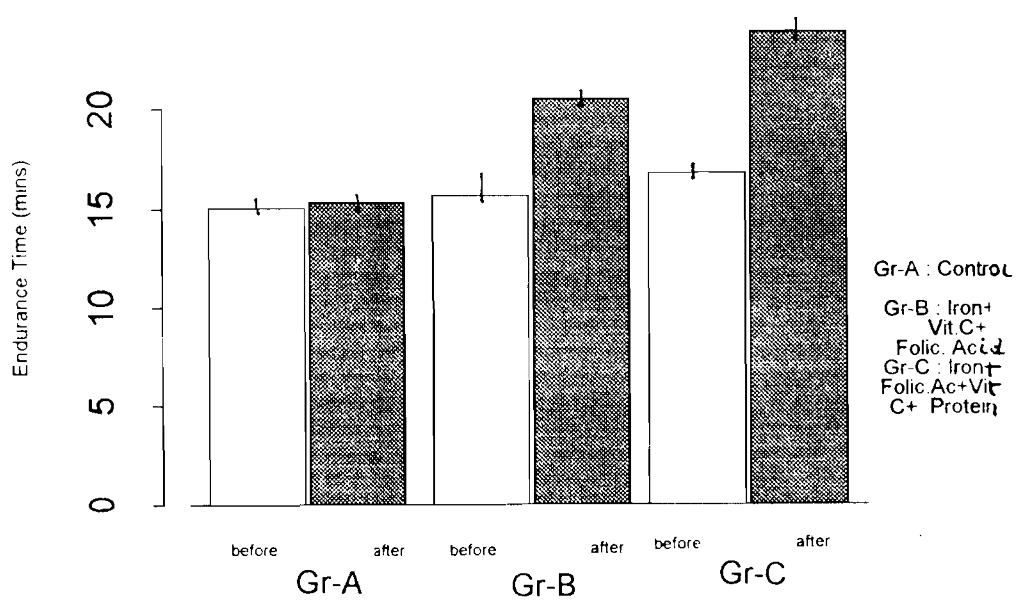

Fig.2: Mean ± S.D. of Endurance Time of female athletes before and after 15 days supplementation

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Some Phenological Characteristics of *Azadirachta Indica* A. Juss in Lateritic Areas of West Bengal

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Abstract

Phenological behaviour of Azadirachta indica has been studied at two sites under lateritic soil condition of south West Bengal. The species is deciduous in lateritic region and period of leaf fall extends from November to January with slight deviation. New leaves appear in early January with few older leaves still remaining on the tree. Flowers appear after new leaf appearnace during mid to late March and in profusion during April and May. Fruiting occurs subsequently. Seasonal activity in A. indica in South West Bengal is more conspicuous in drier months.

Key words : *Azadirachta indica*, Phenological behaviour, Lateric soils, West Bengal

Introduction

Phenology is an important natural phenomenon periodically recurring with respect to the changes of climate and physical environment. In some other species phenological changes are demarcated to a great extent. *Azadirachta indica* A. Juss, though not a very abundant forest species, is commonly found both in urban and rural areas. Natural regeneration is very common with this species.

Need to evaluate phenological data on economically useful species has long been felt in the field of botany and forestry. In the light of present findings of the medicinal values of the tree, its economic importance has been increased manifold. This is one reason why it is being recommended for social forestry plantation programmes. Attempts have been made by various workers like Holmes (6), Sagreiya (9), Kaul and Raina (7), Bisht et al (3) and Beniwal (2) to collect phenological data onthe flora of different regions. Singh et al (3) have studied phenological data of Madhuca indica Gmel in a systematic way. No proper attempt has yet been made to study the phenology of economically important species in the lateritic region of West Bengal.

Site details and Methodology

The lateritic area of south West Bengal lies almost 50-70m above mean sea level. Due to its topography, which is mostly undulated, climate and edaphic factors, the area manifesta a distinctive pattern of vegetation. In this lateritic area to sites viz., Midnapore town, situated on 22°35'10" N Latitude and 88°20'E Longitude and Arabari forest range, situated within 21°36'35" to 22°57'10" N Latitutes and 88°12'40" to 88°35'50" Longitudes have been selected for study. This report is the result of observations recorded from January 1993 to December 1994.

Data have been collected at every 15 days interval to keep notes on different phenological behaviours in both the sites. <u>A. indica</u> trees (ten at each site) of different ages ranging from 5 to 31 years and belonging to different localities have been earmarked for the study. Data of different phenological behaviour concerning leaf fall leaf occurrences, flowers and fruits have been collected from both the sites and systematically compared. In Midnapore town the trees are generally found on road sides and homestead lands, whereas in Arabari forest range the trees are found in association with other forest species. The average distance between the two sites is 40 km. Climatologically, November to January are colder months and summer extends from March to middle of June to September (Table 1). During October, with the retreat of monsoon, autumn sets in Autumn and spring are not well marked seasons of the year. Phenogram of the species describing the phenological calender is given in Figure 1.

According to Champion and Seth (4) the vegetation of the area falls under major group II i.e., dry tropical forests, Group V (Tropical dry deciduous forest), sub group 58 (Northern tropical dry deciduous forest), type C, i.e. dry sal bearing forest Sub-type GC (Dry peninsular Sal forest). The forests are dominated mainly by coppice sal trees.

Results and Discussion

The species in general is a deciduous one, leaf fall occurring from November till January. Flowering occurs during March to June. Normal fruiting occurs from March till mid July, but during mid June to early July there is profuse fruiting. The onset of profuse growth activity is marked by the onset of wet season in this region. Middle of summer marks the phase of lowest plant growth as it is the driest and hottest part of the year. Occasional thunder showers and advent of rainy season during mid June lead to comparatively greater plant acitivity.

The pattern of leaf fall in A. indica at both the study sites corresponds to the advent of dry season. The period of leaf fall extends from November to January with slight deviation from one site to another (Table 2). Leaf fall during the beginning of dry season may be due to water stress as this period is totally rainless or with negligible rain at both the sites. The effect of photoperiodism and mineral deficiency on leaf fall can not also be ruled out.

It is observed that new leaves appear in the month of early January when there are still some old leaves in the tree. Older leaves, of course, shed after few days. Though leaf commencement occurs form January, maximum leaf abundance is observed from June to October. This may be due to the prevalence of most favourable condition as a result of occaasional rains in late summer followed by rainy season.
Flowers are 0.3-0.4 cm across, white, with sweet fragrance and generally appear new leaf appearance. New foliage is red, turning green within one or two weeks. Fruiting lasts for a very short period. Flowering and fruiting are the two most important phenological events as periodicty of flowering is an indicator of fruiting. This, in turn, gives informtion about the proper time of seed collection (1). Maximum flowering in *A. indica* during April and May, in the present observation, is related with the high temperature and low rainfall conducive for development of sex organs. However, Guhabakshi (5) observed the flowering and fruiting of neem in Murshidabad district of West Bengal only occasionally but throughout the year.

The comparative study of phenological events that took place at the two sites shows that at Arabari (Site II), leaf fall occurs late by 2 to 3 weeks in comparison with Midnapore town (Site I), whereas flowering occurs early by at least one week. This may be attributed to the slight difference in geographical positions and climatic condition (Table 1) as inferred by Mulik and Bhosale (8).

From the present phenological accounts it is clear that seasonal activity in *A. indica* of South West Bengal is more conspicuous in drier months i.e. from January to May. The phenological cycle starts from leaf fall phase followed by blossoming phase. The phenomenon of emergence of flowers on bare branches, which is the characteristic of a deciduous tree, is not common in *A. indica* under study. The tree exhibits flowering phase after new foliage phase. Fruiting phase occurs subsequently.

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Table 1

Month-wise mean maximum temperature , minimum temperature and rainfall at Midnapore and Arabari (Average of 1982-92 data)

	Midnapore Town			Arabari		
	Max. Temp. (°C)	Min Temp. (°C)	Rainfall (mm)	Max. Temp. (°C)	Min Temp. (°C)	Rainfall (mm)
January	26.7	13.2	13.3	32.0	12.0	21.0
February	29.7	15.9	22.7	37.5	13.0	69.5
March	35.2	20.9	30.1	38.0	21.0	122.0
April	38.6	24.6	50.2	39.5	20.5	78.9
May	38.3	26.3	92.3	38.5	18.5	309.7
June	35.4	26.4	230.0	41.0	23.0	207.8
July	32.0	25.8	318.1	35.5	23.5	351.5
August	31.9	25.8	339.1	35.5	25.0	279.8
September	32.1	25.4	284.0	35.5	24.5	150.5
October	31.2	23.0	143.8	35.5	21.0	6.0
November	28.8	16.9	4.0	34.0	14.0	----
December	26.8	15.2	3.3	29.0	11.0	-----

Table 2

Observations of phenological events of *A. indica* at two sites

Sl. No.	Events	Midnapore Town	Arabari
01	Beginning of leaf fall	Early November	Late November
02	Completion of leaf fall	Early January	Mid January
03	leaf commencement	Mid January	Mid January
04	Duration of maximum leaf commencement (abundance)	Late May to late October	Late May to end of October
05	Beginning of flowering	Mid March	Early March
06	Duration of flowering	Mid March to early June	Early March to late May
07	Closing of flowering	Mid June	Mid June
08	Beginning of fruiting	Late March	Mid March
09	Closing of fruiting	Early July	Mid July

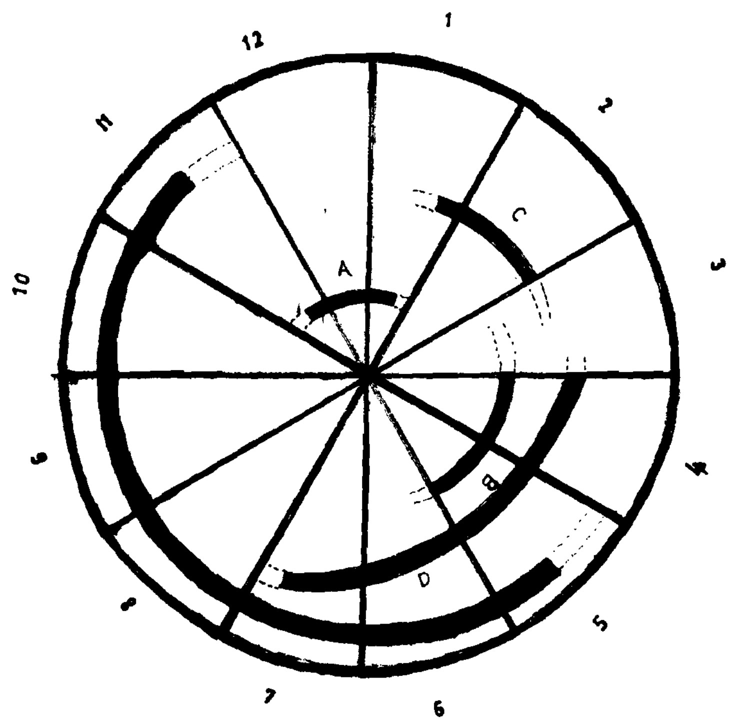

Fig.1 Phenogram of *Azadirachta indica* in Lateritic Soil region of West Bengal.

Legends: (i) ::: ::: represents extending period of phase.

(ii) Nos. 1-12 in circle represent months.

(iii) A - Leaf fall.

B - Flowering.

C - New foliage.

D - Fruiting.

E - Vegetative growth.

A Brief Report on the 14th ICAES

Rajat Kanti Das, Editor-in-Chief, VUJBS

The 14th International Congress of Anthropological and Ethnological Sciences held at the College of William and Mary, Williamsburg, Virginia, U.S.A. from July 26, 1998 to August 1, 1992 was attended by academics and researchers from about 30 countries all over the world including Australia, Austria, Bangladesh, Croatia, England, India, China, Chile, Ghana, Kenya, Tanzania, Latavia, Brazil, Netherlands, Germany, Polland, France, Denmark, Hungary, Mexico, Russia, Canada, Italy, U.S.A. It was the first time since 1973 the conference had been held in the United States. The Conference aroused a lot of interest among the local people, some of whom had participated in a big way offering themselves to be the hosts of some participants coming from abroad.

The Congress' theme was, "The 21st Century : The Century of Anthropology". From July 27, 1998 to July 31, 1998 as many as 20 commisions, 7 workshops, 3 plenary sessions and over 200 academic sessions were held. Out of 20 commissions, a few had focus on biological and environmental aspects of human existence. Mention may specifically be made of the Commission on Aging and the Aged chaired by A. Bittles, the Commission on Human Ecology by N. Wolanski, the Commission on Medical Anthropology and Epidemiology by P. Ruden and the Commission on the Anthropology of Aids by D. Pitt. There were academic sessions devoted to different facets of biological/physical anthropology, some of which are listed below :

(1) **Genetics and Dermatoglyphics** with Norris M. Durham (University of Northern Iowa) and Kathleen M. Fox as Organizers.

(2) **Anthropology of Aging : Critical Retrospectives** with Maria G. Caltell (Association for Anthropology and Gerontology. The Field Museum of Natural History) as Organizer.

(3) **Drinking : An Anthropological Approach - Biocultural Aspects** with Igor de Garne (Centre national de la Recherche Scientifique, Lasseube, France) as Organizer.

(4) **Women and Reproductive Health In Asia** with Hiroko Sue Hara (Ochanomizu University) and Margaret Lock (Mc Gill University) as Organizers.

(5) **From Calipers to Molecular Biology : The Study of Ancient Maya Skeletal Remains** with Frank P. Saul (Medical College, Ohio) and Lourdes Morquez Morfin (INAH) as Organizers.

(6) **Epidemiological Perspectives in Medical in Medical Anthropological Studies - Demography, Biology and Bioethics** organized by Pavao Ruden (University of Zagreb), Andre Charentre (Universite Bordeaux 2).

(7) **Ecology and Aging** organized by Napoleon Wolanski (Cinvestor).

(8) **Anthropological Genetics in the 21st Century** with Michael H.Crawford (University of Kansas) in Chair.

(9) **Rethinking Biocultural Anthropology for the 21st Century** Organizers/Chair : Alan H. Goodman (Hampshire College). Thomas L. Leatherman (University ofSouth Carolina).

(10) **Ecological Anthropology : International Retrospective and Prospective Analysis** Organizer/Chair : Leslie F. Sponsel (University of Hawaii).

(11) **Growth, Nutrition and Biocultural Changes - NE Approaches to their Study** Organizer/Chair : Stanley J, Ulijaszek (University of Cambridge), Fugene Kobyliansky (Tel Aviv University).

(12) **Concept of Health, Health Facilities and Social Responsibility** Organizer/Chair : Anna Hohenwart-Geralachstein (Institut fur Volkerkunde).

(13) **Health and Fitness with Advancing Age/Aging and Dementia** Organizer/Chair : Alan Bittles (Edin Cowan university, Perth, Western Australia).

(14) **Molecular Anthropology in the 21st Century** Organizer/Chair : S.S.Papiha (University of New Castle upon Tyne) and Ranjan Deka (University of Cincinnati).

(15) **The Future of Aids** Organizer/Chair : David C. Pitt (Switzerland).

(16) **Anthropology and Biodemography of the Population of the ALPS** Organizer/Chair : Gilles Boetsch (CNRs) and Emma Rabino-Massa (Laboratorio Di Antropologia).

(17) **Anthropology and Medicine** Organizer/Chair : Timothy Gage (University at Albany SUNY).