which are benthic metazoans. Availability of *Ochetostoma* sp. in the gut has further confirmed the transfer of significant amount of energy into sciaenids by benthos feeding. The sciaenid production ranged from 7.1 to 25.6 tons yr^{-1} with an average annual production of 13.29 tons.

While these are the biological relationships of demersal production in Karwar waters, there are a few physical effects like hydrological changes and fishing effort which may also have some impact over the production. The model of relationships of demersal production can further be improved upon with a large scale multidisciplinary study.

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CLEOME PILOSA, BENTH., A C_3 PLANT WITH HIGH PHOTOSYNTHETIC EFFICIENCY AND SOLAR TRACKING ABILITY

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CLEOME PILOSA, Benth (Capparidaceae) a C_3 species is found to possess higher photosynthetic rates exceeding those of its C_4 counterpart, *Cleome gynandra*, L. The high photosynthetic rates observed in the C_3 pathway plant, *C. pilosa* are attributed to its ability to track the sun, the high stomatal conductance for carbon dioxide diffusion, high amounts of soluble leaf protein and of the enzyme RuBPCase. The photosynthetic characters of five species of the genus *Cleome* are compared in this report.

The seeds of *C. pilosa* were obtained as a gift from the Kew Botanical Gardens, London. Four other species studied of the same genus were *C. gynandra*, L, *C. viscosa*, L, *C. speciosa*, L and *C. Burmanni*, W & A. The seeds of these species were collected from different parts of India and all the plants were grown in the open garden of the University Campus, Tirupati, in the natural photoperiod and a temperature regime of 31°C by day and 23°C by night. Light intensity at the leaf surface was measured with a Li-Cor LI 170 lightmeter, CO_2 conductance was measured with an MKII porometer (Delta T devices). The photosynthetic rate was determined by $^{14}CO_2$ incorporation into acid stable products[1]. Activities of PEPCase and RuBPCase[2], CO_2 compensation point[3], the levels of soluble protein[4] and chlorophyll[5] were estimated. All the measurements were made on the fully expanded second or third leaf from the top of 6–8 week old plants and the values given are mean of five separate determinations on different dates.

Cleome pilosa has exhibited a striking diaheliotropism and its performance of photosynthesis was quite remarkable. At irradiances of 1400 $\mu E\, m^{-2} s^{-1}$ (400–700 nm) under normal atmospheric conditions at a leaf temperature of 28°C, *C. pilosa* fixed carbon at a rate of 59 mg CO_2 $dm^2\, h^{-1}$. In contrast, the other *Cleome* species showed photosynthetic rates typical of their photosynthetic pathways (table 1). This observation has shown that *C. pilosa* has an exceptionally higher photosynthetic capacity exceeding that of the C_4 species of the same genus. Although there was not much variation in the CO_2 compensation point between *C. pilosa* and *C. speciosa*, the levels of RuBP

Table 1 *Photosynthetic rate, CO_2 compensation, stomatal conductance, PEP and RuBP carboxylase enzyme activities and soluble leaf protein of different species of Cleome genus.*

Plant species	Photosynthetic rate (mg CO_2 dm^2 h^{-1})	Stomatal conductance to CO_2 ($cm.S^{-1}$)	CO_2 compensation point (μ l/l)	RuBP carboxylase enzymes (μ mol.mg^{-1} chl.h^{-1})	PEP carboxylase enzymes (μ mol.mg^{-1} chl.h^{-1})	Total soluble leaf protein ($\mu g/cm^2$)
Cleome viscosa	25.90 ±3.63	0.64 ±0.02	42–48*	230.75 ±12.53	23.25 ± 2.86	332.50 ±13.26
Cleome speciosa	28.01 ±2.77	0.90 ±0.01	18–24	208.50 ±10.88	14.25 ± 1.93	193.25 ±12.27
Cleome gynandra	47.10 ±3.63	0.75 ±0.01	0–5	144.50 ±16.90	490.01 ±23.45	598.25 ±19.43
Cleome Burmanni	24.21 ±2.46	0.72 ±0.01	46–54	226.65 ±12.61	10.75 ± 2.13	319.00 ± 8.61
Cleome pilosa	59.41 ±3.52	1.03 ±0.03	24–28	324.00 ±12.57	44.25 ± 6.90	688.25 ±23.35

All values are mean of five determinations on different days ± standard error.
* Range of CO_2 compensation concentration observed on different days.

carboxylase and the degree of stomatal conductance varied significantly. The high photosynthetic rate observed in *C. gynandra* is due to its C_4 pathway and its CO_2 concentrating mechanism leading to lower CO_2 compensation point. On the other hand, the solar tracking ability combined with the higher RuBPCase levels are believed to result in high photosynthetic efficiency in *C. pilosa*. Such high efficiency of a few C_3 plants was hitherto found particularly in the plant species, *Helianthus annuus* and *Malvastrum rotundifolium*. It is interesting that these species also possess the properties of heliotropism of the leaves[6] with high ability to track the sun and capable of utilizing high irradiances.

The leaves of *C. pilosa* position themselves facing the sun perpendicularly and after the dusk the leaflets fold down towards the leaf axis with adaxial surfaces out, for a gradual reorientation to a pre dawn east facing position. As a result, they remain facing the sun throughout the day. Leaf angles changed during the day in response to the angle of incident sunlight. It is however interesting to note that the solar-tracking ability is independent of the photosynthetic pathway[7] since in this instance it is associated with both C_3 and C_4 pathway species of the same genus as the diaheliotropic behaviour in *C. gynandra* was earlier reported from this laboratory[8].

Diaheliotropism is known[6] to have a tremendous impact on the photosynthetic rates because this behaviour allows a sun lit leaf to experience high solar irradiances and to operate at maximal rates throughout the day. The present results show that *C. pilosa* is a C_3 efficient species and is biochemically superior due to its several characteristics mainly the higher carboxylating enzyme levels, *viz* RuBPCase and PEPCase (compared with the other C_3 species), reduced photorespiration and higher amounts of soluble leaf protein per unit leaf area.

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