Table 3. Annual rate of increase of marked price of *Chemical Abstracts*

Year	Subscription rate (US$)	% of increase over previous year
1988	10900	10.10
1989	11900	9.17
1990	12800	7.56
1991	13900	8.59
1992	15100	8.63
1993	16300	7.95
1994	16800	3.07
1995	17400	3.57
1996	18100	4.02
1997	18900	4.42
1998	19800	4.76

of operating costs are spent to produce the first copy. Around 25 to 33% extra money is involved to generate the CD-ROM (Electronic Infomedia) from the first copy to further design search/retrieval software and user interface.

CAS employs specialists in Chemical Sciences and Information Sciences to produce the *Chemical Abstracts*. The first copy production costs can be saved to some extent if the journal publishers transmit informative abstracts (abstracts with maximum information about the topics dealt in the article concerned) about their journal articles to CAS. The costs of indexing the abstracts as per subject and other fields can be reduced only by intelligent machine indexing tools. The distribution costs are largely decided by the quantum of pages and number of subscriptions.

Subscription cost of *Chemical Abstracts*

The exchange rate (US$) as paid by IIT, Kharagpur for journal subscriptions over the last ten years is summarized in Table 1. The amount paid for subscribing *Chemical Abstracts* (in US $/Indian rupee) as per old records is given in Table 2. This table is different from Table 3 on two counts: firstly, degree granting institutions are eligible for a special grant by which they get some reduction and secondly, it includes handling charges also.

City based information centres

We have seen that it has become increasingly difficult for every library to duplicate costly information sources. To meet this challenge, the government could set up city based 'Data and Information for Science Centres' (DISCs) in places like metros, state capitals, etc. where a host of higher education and research entities are located, and come up with some legislation that the resources subscribed at these centres will be of use to all researchers in and around such a facility. Like the arrangement of special prices and reprints for books, the government, research councils, and the publisher/distributor fraternity can mediate with the international publishers to favour reduced subscription rates for developing countries. The publishers can also benefit in the long run, because when the budget can procure more, libraries may subscribe to more journal titles. This will ultimately increase the total number of unique journal titles available in the country. The National Science Library is functioning in INSDOC, New Delhi and the objectives of this concept may be modified so that at least one copy of a journal of importance to S&T research can be subscribed at some institution, permitting access by researchers working elsewhere.

DISCs should be set up with a provision to hold print as well as electronic versions (most of the publishers offer special combined price, for e.g. the price of *Chemical Abstracts* on Compact Disc in 1998 was $ 22,100, but only $ 7800 for those who wish to add it to their print subscription) of major abstracting/indexing sources in S&T, like *Chemical Abstracts*, *INSPEC for Physics and Engineering*, *Mathematical Reviews*, *Biological Abstracts*, *Engineering Index*, *Current Contents*, GEOREF, MEDLINE, etc. Such centres should also hold better computing and communication infrastructure tolerating queries and novice search by users and provide search results at nominal cost. The facilities available in Information Centres like INSDOC, DESIDOC, NCSI, information facilities of national institutes/laboratories, etc. may be augmented and tested for services as a first step, before setting up more DISCs and realizing their objectives in the future.

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SCIENTIFIC CORRESPONDENCE

Identification of quantitative trait loci associated with grain filling duration in rice (*Oryza sativa* L.)

Growth period of cultivated rice (*Oryza sativa* L.) is divided into three distinct phases, namely GS1 (vegetative phase), GS2 (reproductive phase or period between maximum tillering and 50 per cent flowering) and GS3 (grain filling phase or between flowering and maturity)[1,2]. Most of the variation in duration of rice varieties is attributed to the variability in GS1 phase, while GS2 and GS3 are considered to be relatively unvarying[3]. In fact, it is a standard practice to add thirty days to days to flowering and derive maturity duration. The relative time taken by the plant in each of these phases has a bearing on the grain yield. Between GS2 and GS3 phase, the latter is most important for determining

Table 1. Analysis of variance for three characters in Rice DH population derived from the cross between IR64 and Azucena in Mandya, India

Sources of variation	DF	Mean sum of squares X1	X2	X3
Genotypes	115	183.9**	17.45**	171.4**
Replication	2	4.50	171.25**	137**
Error	230	2.66	4.19	6.45
S.Em+		1.33	1.67	2.07
CD at 5%		2.61	3.27	4.06
CD at 1%		3.43	4.30	5.33
CV (%)		1.48	1.42	7.58

*Significance at 5%.
**Significance at 5% and 1% levels
DF = Degrees of freedom
X1 = Days to 50% flowering
X2 = Days to maturity (total duration)
X3 = GS3 Phase.

Table 2. Identification of QTL controlling GS3 and its associated traits along with flanking markers (MAPMAKER/QTL, Threshold LOD = 1.50)

Location	Trait	Chromosome no.	Flanking markers	Length (cm)	Peak LOD	Variation (%)
IRRI '95	GS3	7	RG477-RG488	10	1.84	6.90
		11	RG167-RG103	26	1.66	9.50
	Days to 50% flowering	5	RZ390-RZ556	28	1.71	8.00
		11	CDO127-RZ638	8	1.97	6.90
	Duration	3	Pgi1-CDO87	4	1.52	5.20
		5	RG313-RG403	28	1.99	9.20
		11	CDO127-RG118	32	2.41	8.30
Mandya '95	GS3	1	RZ730-RZ801	34	1.82	9.40
		3	RZ678-RZ892	12	1.89	7.80
		3	RZ892-RG104	24	2.37	9.80
		8	Amp2-CDO99	8	1.75	7.40
	Days to 50% flowering	1	RZ730-RZ801	30	1.77	9.40
		3	RZ678-RG104	36	3.41	14.50
	Duration	3	RZ892-RZ329	8	1.64	7.20
		7	RG769-RZ488	20	2.37	9.80
		11	RG103-Npb186	34	1.91	8.40

the quality and quantity of grain yield. It is during this phase that photosynthates are translocated to the developing grains/spikelets in the panicle which would finally contribute to grain weight. Therefore, increasing the period of GS3 phase of the growth cycle could contribute to explore unconventional avenues to augment grain yield[4]. There are some positive correlations between grain filling duration and higher grain yield in both rice and corn[5]. Thus GS3 phase unequivocally has a direct bearing on yield determining process. This study is intended to quantify and map quantitative trait loci (QTL) for GS3 phase in rice. To our knowledge, this is the first report on mapping QTL for GS3 phase in rice.

One hundred and fourteen doubled haploid (DH) lines developed from a cross between IR64, an *indica* variety and Azucena, a *japonica* variety[4] were used for this study. A preliminary RFLP map of this DH population was generated by Huang *et al.*[6]. Permanent mapping population like DH lines have an advantage over other segregating material used in genetic studies as replicated measurements are possible. Moreover, less time is involved in identifying and using a genotype directly as starting material in breeding experiments.

The experiment was carried out at two locations. The first experiment was carried out at International Rice Research Institute (IRRI), Philippines during the dry season of 1995 with three replications in randomized complete block design (RCBD). The second experiment was carried out at the Regional Research Station, Mandya representing the Southern dry zone of Karnataka, India during wet season of 1995 with three replications in RCBD. The genotypes were sown in raised dry nursery beds in single rows of two meters length. Thirty-day-old seedlings were transplanted with 20 hills in 1 row (one seedling per hill) and 5 rows per replication with a spacing of 15 cm × 25 cm. Recommended cultural practices including fertilizer application and irrigation were followed to ensure uniform and healthy crop stand. The characters studied were plant height (cm), GS3 phase, days to 50 per cent flowering, days to maturity and grain yield per plant (g). GS3 phase was computed by deducting days to 50 per cent flowering from days to maturity.

The statistical analysis of data was carried out using mean of ten randomly taken plants of each genotype. A total of 175 molecular markers (146 RFLP, 3 isozymes, 14 RAPD and 12 cloned genes) were used to construct a linkage map by using MAPMAKER/EXP and MAPMAKER/QTL software[7].

Parents and the DH lines showed diverse phenotypic values for almost all traits. Analysis of variance for the three characters considered in the study (Table 1) indicated highly significant differences among the genotypes. Transgressive segregants were observed for all the growth and yield-related traits[8]. High heritability estimate ($h^2 = 89.50\%$) and genetic advance (43.15%) over mean were recorded for GS3, suggesting that this trait can be enhanced by selection. Genetic advance for GS3 at selection differential of $K = 2.06$ at 10.93 was moderate, indicating the scope for improvement under selection. Coheritability of GS3 with duration (90.50%) and days to 50 per cent flowering (82.99%) are very high

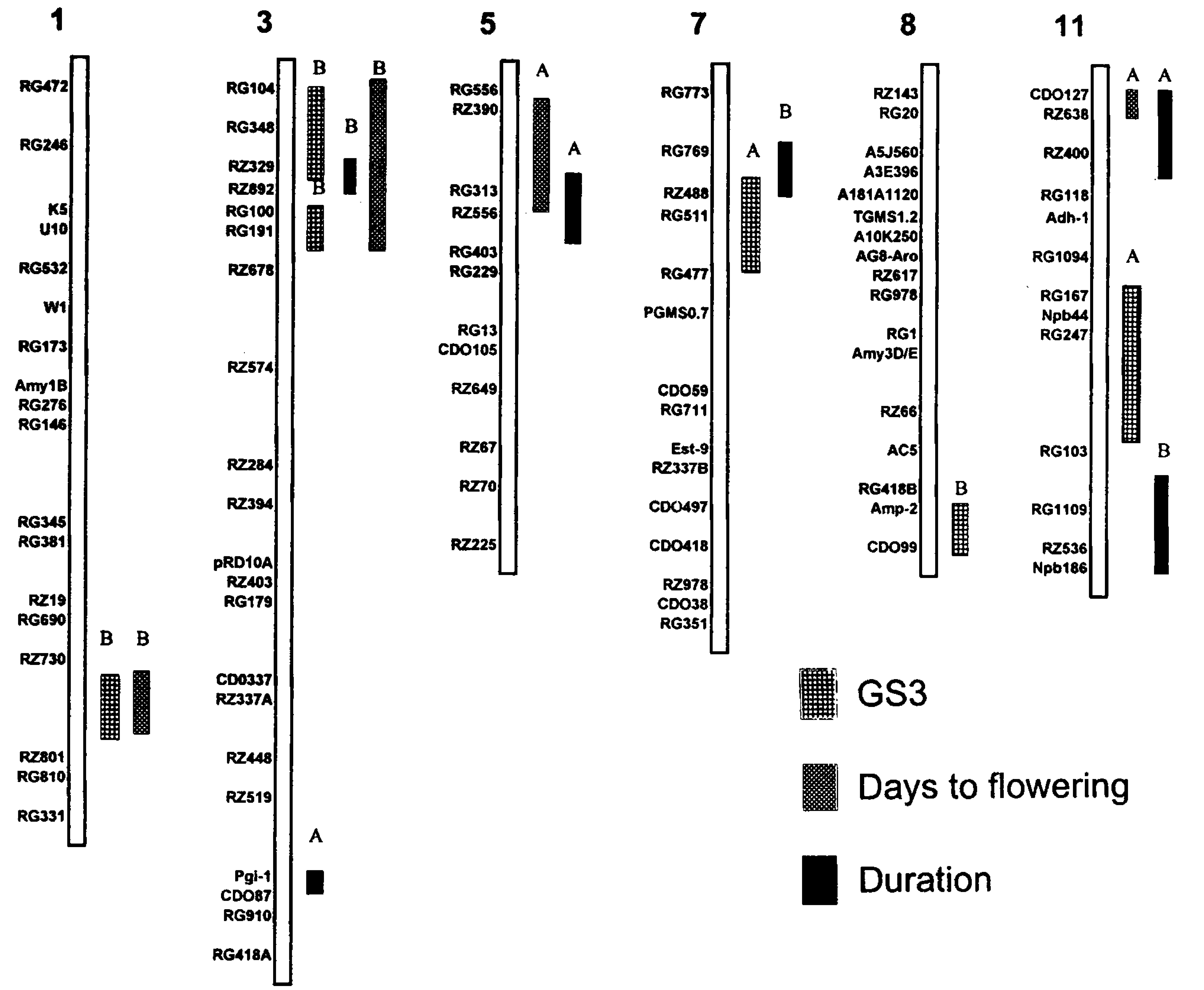

Figure 1. Putative QTL controlling GS3, days to flowering and total duration in IR64/Azucena doubled haploid population of rice at IRRI (A) and Mandya (B).

specifying that combined improvement for these traits can be conceived.

Interval analysis by MAPMAKER/QTL (threshold LOD = 1.50) identified two major and five minor QTL for GS3 (Table 2 and Figure 1). The major QTL on chromosome 3 was also associated with traits such as days to 50% flowering, total duration, number of productive tillers per plant at maturity and panicle exertion[8]. This also overlapped a locus for number of spikelets per panicle and spikelet density[9], and a QTL for grain yield[10]. Since a number of growth and yield-related characters have been linked to this QTL, we speculate either pleiotropic effect or tight linkage. Another locus for GS3 located on chromosome 1 was also found to overlap the QTL for panicle length, panicle exertion, straw weight and harvest index. This QTL also overlapped QTL for number of panicles per plant, number of spikelets per panicle, thousand grain weight, plant height, panicle exertion and panicle length[10].

Classical quantitative genetics assumes that character correlation is attributable to the effect of pleiotropy or very close linkage of genes[9]. If this assumption is true, then the highly correlated traits are expected to have overlapping QTL located in the same regions of rice chromosomes. Multiple effect of QTL on chromosome 3 would suggest corollary increase of GS3 and yield-related traits. A relatively longer period of flowering to maturity is a desirable trait for higher yield potential from plant energy point of view[11], although very little is known about physiology of partitioning of photosynthates at different phases of life cycle of rice. In rice, grain size is physically limited before fifty per cent of flowering[4], agronomists can work out recommendations of split doses of nutrients for increasing the number of filled grains per plant per unit land area by extending the grain filling period. Lazer *et al.*[12] have observed reduction in GS3 under stress compared to well-irrigated condition in wheat. In maize, increase in length of anthesis-silking interval has shown association with drought susceptibility. Thus well-organized reduction in the anthesis-silking interval has direct application on grain yield under drought conditions in maize[13,14].

Some of the QTL identified in this study remained stable across rice populations and also across different locations invigorating the beacon of breaking yield plateau in rice. Marker-aided selection will greatly facilitate genetic metamorphosis toward ameliorating fundamental processes of yield formation. The reliability and stability of QTL in different environments should be tested before using them in breeding programme. The information needs to be generated to correlate extended grain filling interval with grain yield under stressed environments in *indica–japonica* crosses of rice.

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New record of the sympatric distribution of two Asian species of the horseshoe crab

The geographical distribution of four extant species of the horseshoe crab all over the world has been discussed in detail by many workers[1-3]. Co-existence of two or more species of the horseshoe crab at one place has not been reported, so far. In India, 2 species of the horseshoe crab are commonly found along the north-east coast (West Bengal and Orissa) where mature pairs of the horseshoe crab, in amplexus, migrate towards the shore throughout the year for breeding[4]. The co-existence of two species of the horseshoe crab along Orissa coast is reported here.

The surveys for the present study were conducted in the coastal areas of West Bengal and Orissa (lat. 19°16'N, long. 84°53'E and lat. 22°19'N, long. 88°39'E, Figure 1). A shore seine having an area of 200 m^2 was operated with the help of fishermen to collect live specimens from the natural environment during the high tide. The survey was conducted from March 1996 to February 1997 coincident with full/new moon phases. The average number of crabs collected in each lunar phase was recorded and identified.

The percentage of crabs collected during each lunar cycle during the present study is given in Table 1. The population of horseshoe crab along the West Bengal coast (Canning and Digha) comprised only *Carcinoscorpius rotundicauda* (Latreille) in the mangrove swampy areas. In Orissa (Kirtania, Balramgari, Paradeep, Khairnasi and Gopalpur), the population of the horseshoe crab showed only the presence of *Tachypleus gigas* (Müller).

Table 1. Average percentage of the horseshoe crab collected during March 1996 to February 1997

Area surveyed	Species	New moon phase (%)	Full moon phase (%)
West Bengal			
Canning	*C. rotundicauda*	15.0	9.0
Digha	*C. rotundicauda*	–	4.5
Orissa			
Kirtania	*T. gigas*	–	4.5
Balramgari	*T. gigas*	34.0	38.6
Paradeep	*T. gigas*	11.3	9.0
Khairnasi	*T. gigas*	–	4.5
Gopalpur	*T. gigas*	–	4.5
Hukitola	*T. gigas*	2.2	27.2
	C. rotundicauda	4.5	38.6