SOUTH INDIAN MUSIC

BOOK IV

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(Revised and Enlarged)

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Names of Rāgas like Kuranji, Erukalakāmbhoji and Velāvali reveal a tribal origin.

Such ragas as Dvitiya Saindhavi, Tritīya Saindhavi, Chaturtha Saindhavi and Dvitīya Kedāram suggest that these are slightly different forms of Saindhavi and Kedāram respectively.

There are ragas with dual names. Āndolika and Mayūradhvani are one and the same raga; likewise are Sindhu dhanyāsi and Udayaravichandrika; Rāma manohari and Rāmā manohari; and Vanāli and Rasāvali.

The names of some ragas have undergone a slight change. Dhanyāsi is referred to in earlier works as Dhannāsi, Dhanāsi, Dhanāsi, Dhanāsri, Dhanāsari and Dhanyāsi. Yadukulakāmbhoji is refered to as Erukalakāmboji, Yarakalakāmbodhi, and Edukula-kāmbodi.

CHAPTER V

22 SRUTIS

In the history of world music, Indian music is one of the earliest to use quarter-tones. It is the use of quarter-tones and micro-tones that imparts a peculiar charm and flavour to the music of India. Twenty-two such notes i.e. ten notes in addition to the universal twelve notes of the gamut have been in use for centuries. Many ancient Sanskrit and Tamil works refer to the 22 srutis as the foundation of the Indian musical scale. With the progress of the art, a few more srutis have come into use. Theoretically, the number of srutis figuring in Indian music has been estimated by various scholars as 22, 24, 27, 32, 48, 53 and 96. Though in modern music we ase a few srutis in addition to the 22, the number 22 represents the barest minimum of srutis that has been actually used in Indian music from ancient times. A few of these srutis figure in rare ragas and they live only through these ragas. A well-trained ear can perceive and identify at least 50 notes in an octave. In music, however, we are concerned only with those srutis which actually occur in ragas andjwhich bear a concordant relationship with one another. The rest are discarded. The use of these subtle tones is in fact the glory of Indian music and testifies to the highly developed aural powers of the Indian musician. Musicians are not, generally speaking, conscious of the precise frequency values of these srutis, but keeping the melodic picture of the raga in their minds, they are able to sing or play the srutis accurately. Just as a person can speak a language correctly without knowing in detail its

grammar, so also a person can sing a raga or a composition in it correctly, without knowing the frequencies of the notes figuring in the rāga.

The subject of 22 srutis is one of the most difficult branches of the science of Indian music. It can be understood only by persons with many years of musical training. In fact those janya ragas, which can possibly claim more than one janaka mela are put under particular melakartas on the basis of their sruti values only. The melodic individuality of a raga is revealed only when its characteristic srutis are sounded.

A sruti is a note of minute pitch which a refined and trained ear can distinguish. It is the smallest audible difference of pitch. It is a fraction of a semi-tone. There is no such thing as a unit sruti with a constant value. An *eka sruti* (single sruti) *interval* is of three sizes. When we say that there is an interval of one sruti between a pair of notes the value of this sruti interval may be any one of these according to the notes forming the pair. The *values of these srutis are, in the increasing order of pitch: $\frac{81}{80}$ (comma of Didymus : 22 cents), $\frac{25}{24}$ (70 cents) and $\frac{256}{243}$ (Pythagorean Limma : 90 cents). $\frac{81}{80}$ is called the *pramāna sruti*. The other two srutis are termed *nyuna sruti* and *purna sruti* respectively. The term *purna sruti* denotes the eka sruti interval of the highest pitch. The term *nyuna sruti* means the sruti that is slightly less than the *purna sruti*. The octave is divided into 22 intervals of unequal pitch. In other words,

The 3 srutis
See TABLE V

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* The values of srutis can be expressed in terms of vibrations per second or as ratios to the fundamental or in cyclic cents.

the sthāyi is conceived of as the sum total of 22 srutis of unequal size. Notes which are separated from one another by an interval of less than a *pramāna sruti* are not reckoned.

A *dvisruti interval* has two values : $\frac{16}{15}$ and $\frac{135}{128}$. The former is the diatonic semi-tone and is called the *purna dvisruti interval* (112 cents). The latter is slightly less than the semi-tone and is called the *nyuna dvisruti interval* (92 cents). Between the shadja and the suddha rishabha is a semi-tone $\frac{16}{15}$. But between suddha rishabha and chatussruti rishabha is the slightly flattened semi-tone $\frac{135}{128}$ or *nyuna dvisruti* interval—$\frac{16}{15} \times \frac{135}{128} = \frac{9}{8}$.

A *trisruti interval* has a constant value $\frac{10}{9}$ (182 cents) and corresponds to the minor tone. A *chatussruti interval* has also a constant value $\frac{9}{8}$ (204 cents) and corresponds to the major tone.

A *chatussruti interval* comprises two pramāna srutis (commas), one nyūna sruti and one pūrna sruti (limma) $\frac{81}{80} \times \frac{81}{80} \times \frac{25}{24} \times \frac{256}{243} = \frac{9}{8}$.

A chatussruti interval comprises a pūrna dvisruti interval and a nyūna dvisruti interval $\frac{16}{15} \times \frac{135}{128} = \frac{9}{8}$.

A *panchasruti interval* is equal to $\frac{32}{27}$ (294 cents). Between the chatussruti rishabha and the suddha madhyama is a panchasruti interval—$\frac{9}{8} \times \frac{32}{27} = \frac{4}{3}$.

A *shatsruti interval* is equal to $\frac{6}{5}$ (316 cents). There is a shatsruti interval between antara gāndhāra and panchama : $\frac{5}{4} \times \frac{6}{5} = \frac{3}{2}$.

The difference between a shatsruti interval and a panchasruti interval (6 - 5) is a comma $\frac{81}{80}$ or a pramana sruti.

The difference between a panchasruti interval and a chatussruti interval (5 - 4) is a limma $\frac{256}{243}$ or a purna sruti.

The difference between a chatussruti interval and a trisruti interval (4 - 3) is a comma $\frac{81}{80}$ or a pramana sruti.

The difference between a trisruti interval and a dvisruti interval (3 - 2) is $\frac{25}{24}$ or a nyuna sruti.

The difference between a dvisruti interval and an ekasruti interval of the purna type (2 - 1) is a comma $\frac{81}{80}$ or pramana sruti.

European musicians, brought up in the tradition of equal temperament, while listening to Indian music employing quarter-tones are likely to get the impression that impure notes are being played. This is an erroneous notion. It is of interest to note that in recent years attempts have been made in Europe to write quarter-tone music and pianos containing 24 keys to the octave have been made. A whole opera employing quarter-tone music was performed some years ago in Germany.

Since equal temperament is resorted to in Western music, a quarter-tone there will mean an exact half of a semi-tone i.e. 50 cents which is not the case in Indian music.

It is possible to have 22 frets on the vina finger-board to indicate the 22 sruti-sthanas and play music, but this arrangement will become too unwieldy. The present

arrangement by which we produce the srutis by deflecting the string from the lower svarasthanas is quite satisfactory. The distribution of 22 srutis over the 12 svarasthanas is an easy and workable arrangement. The 12 frets for an octave on the Vina do not warrant the assumption that only 12 notes are used in an octave.

In ancient music, the 22 srutis were distributed over all the sapta svaras. But later on, when *sa* and *pa* came to be regarded as *avikruta* svaras, (i.e., changeless and not admitting of varieties) *sa* and *pa* took one sruti each and the remaining 20 srutis were distributed amongst the 5 notes : *ri ga ma dha* and *ni* at the rate of 4 for each note. Thus $4 \times 5 = 20 + 1 + 1 = 22$ srutis. Hence the significance of the statement : *svaras are 7, svarasthanas are 12 and srutis are 22.*

The 22 srutis of ancient music were not mere theoretical postulates. They were solid musical facts and were ascertained when Rig Vedic hymns and melodies were sung with *sa*, *ma* and *pa* as the tonic note or adhara shadja.

A musical scale is a collection of all the notes used in the octave in a particular country. A musical scale is a gradual evolution. It is the result of centuries of musical thought and practice.

The 22 srutis are the foundation of the original scale and they were derived primarily for fixing the values of the suddha svaras i.e., the notes of the *Sama gana*. Excepting for the notes *sa*, *ma* and *pa*, the term *suddha svara* in ancient music and modern music denotes notes of entirely

different pitch. The frequencies of these notes have been given in the preceding chapter. The srutis are derived upon the principle of *samvāditva* or consonance. The 22 srutis were evolved by the Cycle of Fifths and Fourths *i.e.*, by the *sa-pa* and *sa-ma* methods (*samvāda dvaya*).

षड्जपञ्चमभावेन श्रुतिर्द्वाविंशतिं जगुः ॥

—Ahobala's *Sangita pārijāta*.

i.e., the 22 srutis are arrived at by the shadja-panchama bhāva

(*Note.* A Panchama interval below the shadja gives the suddha madhyama.). Thus a cycle of *under fifths* will give the values obtained in the Cycle of Fourths.

The traditional mention of Panchama and Madhyama as the basis of derivation should be taken only as illustrative and not exhaustive. The Cycle of Thirds *sa-ga* series will furnish other srutis as well.

All the 22 srutis become svaras in some raga or other. Srutis actually used in a raga attain the status of svaras in that raga and the other notes remain merely as srutis.

It will be useful at this stage for the student to become familiar with the frequencies of the easier srutis and then to study the more difficult ones.

From the Harmonic Series, we see that the values of the successive intervals are :— a sthāyi (octave), a panchama (perfect 5th), suddha madhyama (perfect 4th), antara gāndhāra (major 3rd), sādharana gāndhāra (minor 3rd),

etc. From the 8th to the 9th is a chatussruti (major tone), from the 9th to the 10th is a trisruti (minor tone) and from the 15th to the 16th is a dvisruti (diatonic semi-tone). The other successive intervals are of interest only from the academic point of view and are not of musical importance.

The Harmonic Series again gives us the values of Panchama as $\frac{3}{2}$; Antara Gāndhāra as $\frac{5}{4}$ and Chatussruti Rishabha as $\frac{9}{8}$.

There is an interesting point about these three notes :—

Panchama is the harmonic mean of shadja and tāra shadja, *i.e.*, $\frac{1+2}{2}=\frac{3}{2}$.

Antara Gāndhāra is the harmonic mean of shadja and panchama $\frac{1+\frac{3}{2}}{2}=\frac{5}{4}$

Chatussruti Rishabha is the harmonic mean of shadja and antara gāndhāra $\frac{1+\frac{5}{4}}{2}=\frac{9}{8}$

The *sa-pa series* or the Cycle of Fifths gives us the following notes :—

sa (the starting-note of the cycle)$=1$; Panchama$=\frac{3}{2}$.

Panchama of this Panchama is the tāra sthāyi Chatussruti Rishabha $\frac{3}{2}\times\frac{3}{2}=\frac{9}{4}$ which is a *compound interval. This note in the madhya sthāyi will have the value $(\frac{9}{4}\div\frac{2}{1})\frac{9}{8}$.

* A compound interval is an interval greater than an octave.

The Panchama of this Chatussruti Rishabha gives us the Chatussruti Dhaivata $\frac{9}{8} \times \frac{3}{2} = \frac{27}{16}$ which is the Pythagorean major 6th.

The Panchama of this Chatussruti Dhaivata gives us a note in the tara sthayi which is slightly above the Antara Gāndhāra $\frac{27}{16} \times \frac{3}{2} = \frac{81}{32}$. This note in the madhya sthayi $= \frac{81}{32}$ divided by $2 = \frac{81}{64}$. This note is higher than the Antara gandhāra by a comma interval $\frac{5}{4} \times \frac{81}{80} = \frac{81}{64}$. This note is called the Tīvra Antara Gāndhāra or the Chyuta Madhyama Gāndhāra and is the Pythagorean major 3rd.

Its Panchama gives us the note : Tivra Kākali Nishāda or the Chyuta Shadja Nishādha $\frac{81}{64} \times \frac{3}{2} = \frac{243}{128}$. This note is the Pythagorean major 7th.

The *sa-ma* series or the Cycle of Fourths gives us the following notes :—

sa (the starting-note of the cycle) $= 1$

Its suddha maddyama $= \frac{4}{3}$.

The suddha madhyama of this madhyama is the flattened Kaisiki Nishāda : $\frac{4}{3} \times \frac{4}{3} = \frac{16}{9}$.

The suddha madhyama of this nishāda is the tara sthāyi flattened sādhārana gāndhāra :

$\frac{16}{9} \times \frac{4}{3} = \frac{64}{27}$. This note in the madhya sthāyi will have the value $\frac{64}{27}$ divided by $2 = \frac{32}{27}$

The suddha madhyama of this gāndhāra is the flattened form of suddha dhaivata :—

$$\frac{32}{27} \times \frac{4}{3} = \frac{128}{81}$$

The suddha madhyama of this dhaivata is the eka sruti rishabha of tāra sthāyi :—

$\frac{128}{81} \times \frac{4}{3} = \frac{512}{243}$. This note in the madhya sthāyi will have the value $\frac{256}{243}$.

If suddha madhyama is taken as shadja its antara gāndhāra will be the note of frequency : $\frac{4}{3} \times \frac{5}{4} = \frac{5}{3}$. This note is the Trisruti Dhaivata and is at a trisruti interval from Panchama. The same note a Fifth below gives us the Trisruti Rishabha $\frac{10}{9}$ (minor tone).

Between the Antara gāndhāra and the suddha madhyama is a dvisruti interval, $\frac{16}{15}$; thus $\frac{5}{4} \times \frac{16}{15} = \frac{4}{3}$. Between he kākali nishāda and tāra shadja is also a dvisruti interval : $\frac{15}{8} \times \frac{16}{15} = 2$. The suddha rishabha is a dvisruti interval from shadja and its frequency is $\frac{16}{15}$.

The sādhārana gāndhāra is a dvisruti interval from chatussruti rishabha and its frepuency is : $\frac{9}{8} \times \frac{16}{15} = \frac{6}{5}$.

The Prati madhyama is a dvisruti interval from suddha madhyama and its frequency is : $\frac{4}{3} \times \frac{16}{15} = \frac{64}{45}$.

The ratio of the frequency of a note to that of a lower note is termed the interval between them. In order to obtain the interval value between any two notes, divide the frequency of the higher note by that of the lower note. Thus the interval between suddha madhyama and Panchama is a chatussruti interval : $\frac{3}{2} \div \frac{4}{3}$, *i.e.* $\frac{3}{2} \times \frac{3}{4} = \frac{9}{8}$.

It consequently follows that a lower note multiplied by the interval between it and the next higher note gives the pitch of that higher note. Thus $\frac{5}{4} \times \frac{16}{15} = \frac{4}{3}$.

And If $n = $ the number of vibrations of *sa*, then the frequency of any other note say like chatussruti rishabha $=$

$\frac{9}{8} n$; that of antara gandhara $= \frac{5}{4} n$ and so on. If the interval is inversed we get the vibrating length of the string.

A careful and analytical study of the Sankarābharana scale reveals to us that almost all the important intervals used in music figure therein.

There is a dvisruti interval between ga and mi :

$$\frac{5}{4} \times \frac{16}{15} = \frac{4}{3}.$$

There is a trisruti interval between ri and ga

$$\frac{9}{8} \times \frac{10}{9} = \frac{5}{4}.$$

There is a chatussruti interval between ma and pa

$$\frac{4}{3} \times \frac{9}{8} = \frac{3}{2}.$$

There is a panchasruti interval between ri and ma :

$$\frac{9}{8} \times \frac{32}{27} = \frac{4}{3}.$$

There is a shatsruti interval between ga and pa :

$$\frac{5}{4} \times \frac{6}{5} = \frac{3}{2}.$$

In the sruti scheme, precedence is first given to sa-pa values then to sa-ma values and then to sa-ga values.

It is not unusual for a raga to change some of its characteristic srutis in particular sanchāras. Occasionally in some ragas, the frequencies of svaras differ in their ārohana and avarohana. Rishabha and Gāndhāra of Todi are instances in point.

The Table on the next page gives the modern names for the 22 srutis, their frequencies as also the rāgas in which they are met with. The four sruti varieties of a note are for the sake of convenience, referred to in the increasing order of pitch as, ra, ri, ru, re ; ga, gi, gu, ge and so on,

TABLE V.—Đvavimsati (22) Sruti Chart.

Name of the sruti	How represented	Frequency	Value in vibrations per second with sa=240	Value in cyclic cents	Ragas in which the srutis are met with
Shadja	sa	1	240	0	All ragas
			256 /243		
Ekasruti Rishabha	ra r_1	$\frac{256}{243}$	252.8	90	Gaula
			81 /80		
Dvisruti ,,	ri r_2	$\frac{16}{15}$	256	112	Māyāmalavagaula
			25 /24		
Trisruti ,,	ru r_3	$\frac{10}{9}$	266.6	182	Bhairavi
			81 /80		
Chatussruti ,,	re r_4	$\frac{9}{8}$	270	204	Sankarābharana
			256/243		
{ Suddha Gāndhāra or Komal ‹ Sādhārana Gāndhāra	ga g_1	$\frac{32}{27}$	284.4	294	Bhairavi
			81/80		
Sādhārana Gāndhāra	gi g_2	$\frac{6}{5}$	288	316	Kharaharapriya
			25 /24		
Antara Gāndhāra	gu g_3	$\frac{5}{4}$	300	386	Sankarābharana
			81 /80		

TABLE V.—Dvavimsati (22) Sruti Chart—(Contd.)

Name of the sruti	How represented		Frequency	Value in vibrations per second with sa = 240	Value in cyclic cents	Ragas in which the srutis are met with
Chyuth madhyama ga or the Phythagorean major 3rd	**ge**	**g₄**	$\frac{81}{64}$	303.75	408	Devagandhāri
				256/243		
Suddha madhyama	**ma**	**m₁**	$\frac{4}{3}$	320	498	Kuntalavarāli
				81/80		
Tivra suddha ,,	**mi**	**m₂**	$\frac{27}{20}$	324	520	Begada and Gaulipantu
				25/24		
Prati ,,	**mu**	**m₃**	$\frac{45}{32}$	337.5	490	Kalyāni
				81/80		
Chyuta panchama madhyama	**me**	**m₄** →$\left\{\begin{matrix}729\\512\end{matrix}\right\}$ or $\frac{64}{45}$	→(341.7) or 341.3	610 →612	Varāli
				256/243		
Panchama	**pa**		$\frac{3}{2}$	360	702	All ragas where p is not varja
				256/243		
Ekasruti dhaivata	**dha**	**d₁**	$\frac{128}{81}$	379	792	Sāveri
				81/80		
Dvisruti dhaivata	**dhi**	**d₂**	$\frac{8}{5}$	384	814	Māyāmālavagaula
				25/24		
Trisruti dhaivata	**dhu**	**d₃**	$\frac{5}{3}$	400	884	Kāmbhoji
				81/80		
Chatussruti dhaivata or the Pythagorean major 6th	**dhe**	**d₄**	$\frac{27}{16}$	405	906	Kalyāni
				256/243		
Suddha nishāda or the Komala kaisiki nishāda	**na**	**n₁**	$\frac{16}{9}$	426.6	996	Bhairavi
				81/80		
Kaisiki nishāda	**ni**	**n₂**	$\frac{9}{5}$	432	1018	Kharaharapriya
				25/24		
Kākali nishāda	**nu**	**n₃**	$\frac{15}{8}$	450	1088	Sankarābharana
				81/80		
Chyuta shadja nishāda or the Tīvra kākali nishāda or the Pythagorean major 7th	**ne**	**n₄**	$\frac{243}{128}$	455.6	1110	Kuranji
				256/243		
Tāra shadja	**sa**			480	1200	All ragas except the Nishādānty Dhaivatāntya an Panchamānty rāgas

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NOTE.—The notes *suddha gāndhāra* and *suddha nishāda* in the above Table are the same as the old shadja grāma gāndhāra and nishāda, and *not* the same as the suddha gāndhāra and suddha nishāda of the scheme of 72 Melakartas. Likewise it should be noted that the mnemonics *ra ri ru re*; *ga gi gu ge* etc., have not the same values as the *ra ri ru* and *ga gi gu* of the 72 Melakarta scheme. In the above Table only those ragas in which the srutis are characteristically met with are given as examples.

From the above Table it will also be seen that,

(1) there is a pūrna sruti interval $(\frac{256}{243})$ between *sa* and ekasruti rishabha ; between chatussruti rishabha and komala sādhārana gāndhāra ; between *pa* and ekasruti dhaivata ; between chatussruti dhaivata and komala kaisiki nishāda ;

(2) there is a nyūna sruti interval $(\frac{25}{24})$ between dvisruti rishabha and trisruti rishabha ; between sādhārana gāndhāra and antara gāndhāra ; between dvisruti dhaivata and trisruti dhaivata ; between kaisiki nishāda and kākali nishāda ; $(\frac{25}{24}$ is the deisis).

(3) there is a pramāna sruti interval $(\frac{81}{80})$ between ekasruti rishabha and dvisruti rishabha ; between trisruti rishabha and chatussruti rishabha; between komal sādhārana gāndhāra and sādhārana gāndhāra ; between antara gāndhāra and chyuta madhyama gāndhāra ; between ekasruti dhaivata and dvisruti dhaivata ; between trisruti dhaivata and chatussruti daivata ; between komal kaisiki nishāda and kaisiki nishāda ; between kākali nishāda and chyuta shadja nishāda.

An octave consists of 10 pramana srutis (commas) 220 cents, 7 pūrna srutis (limmas) 630 cents and 5 nyūna srutis (350 cents) ; Total 1200 cents.

From Table V it will be seen that the difference between a *purna sruti* and a *nyuna sruti* is 20 cents. Likewise the difference between a *purna dvisruti* and a *nyuna dvisruti* is 20 cents. This interval which is less than a pramāna sruti was too subtle and the ancient scholars therefore ignored it from the point of view of practical music (*Sruti Sādhārana Prakarana*).

Although the frequencies of the srutis are not mentioned in terms of vibrations per second or even in fractions in ancient works, still from the methods outlined for their derivation we are able to fix their values and with modern knowledge we are able to prove mathematically the accuracy of the scheme of 22 srutis. The aesthetic logic behind the scheme of 22 srutis is also clear.

It is however clearly mentioned in ancient works that the octave bears a *dviguna* relationship *i. e.* the frequencies of a note and its octave bear the ratio 1 : 2. When a stretched string is stopped at 1/3 length and the segmented lengths of the string are plucked consecutively, it will be found that the shorter and the longer segments give the notes tāra panchama and madhya panchama respectively. This again is an example of *dviguna* relationship. The frequency of Panchama was thus fixed as 3/2 and the frequencies of all the other srutis were then calculated.

The four srutis of *ga, ma* and *ni* may also be referred to as ekasruti, dvisruti, trisruti and chatussruti gāndhāra, madhyama and nishāda respectively after the manner of rishabha and dhaivata.

It is also worthy of note that the four srutis of each of the notes: *ri ga ma dha ni* progress in a symmetrical order.

The frequencies given for the 22 srutis in Table V are those which have been arrived at after mature deliberations in the conferences held during recent years. When a suitable apparatus which will indicate the frequencies of notes sung or played is devised, we can experimentally prove the values of these srutis. In the Pradarsana Vina, one can see visually the different sthānas of the 22 srutis and perceive their inter-relationships.

The srutis bearing septimal ratios possibly occur in a few ragas. The note of frequency $\frac{7}{6}$ (280 vibrations per second sa = 240) occurs between chatussruti rishabha and komal sādhārana gāndhāra. The note of frequency $\frac{7}{5}$ (336 vibrations per second occurs between tivra suddha madhyama and prati madhyama. Since this note is less that Kalyāni madhyama by a very small interval, it will be difficult aurally to distinguish between the notes $\frac{7}{5}$ and $\frac{45}{32}$. The note of frequency $\frac{7}{4}$ (420 vibrations per second) occurs between chatussruti dhaivata and komala kaisiki nishāda. The notes $\frac{7}{6}$ and $\frac{7}{4}$ are samvādi svaras.

The notes of frequencies $\frac{25}{24}$ and $\frac{25}{16}$ also are samvādi svaras and are rarely used.

Just as there are twin svarasthānas for each of the 5 notes *ri ga ma dha ni*, there are twin srutis for each of the ten svarasthānas, other than *sa* and *pa*. No two consecutive srutis can occur in a raga,

It is desirable and certainly will be more accurate to describe the svaras figuring in ragas in terms of their precise sruti values. But such a description will be of use only to a limited few and hence the traditional method of describing ragas in terms of their svarasthānas has been adopted in this book in the hope that the students will find the correct srutis with their teachers' help. The continuous curve and the constant *portamento* in Indian classical music is due to the fact that it is more the interval that is *sung* or *played*, rather than the mere note.

The topic of 22 srutis as understood and applied in modern music (*ādhunika sangita*) has been dealt with in detail in this chapter. We shall now see its application in ancient music.

As has already been stated, the 22 srutis were primarily derived for the purpose of fixing the suddha svaras of the ancient scale. Since the idea of *sa* and *pa* as *avikruta svaras* had not yet dawned, even *sa* and *pa* were regarded as admitting of varieties, and thus we have the 22 srutis distributed over the sapta svaras in the order 4 3 2 4 4 3 2. Names for the 22 srutis are found in Bharata's *Nātya sāstra* and these names are repeated in the *Sangita ratnākara*, *Sangīta pārijāta* and *Sangita darpana*. But Narada's *Sangita makaranda* and Bhāvabhatta's *Anupa sangita vilāsa* give different sets of names for the 22 srutis. *Ugra* is a name figuriug in the flrst two nomenclatures. Whereas in Narada's scheme, it is the highest rishabha sruti, in the scheme of others, it is the first nishāda sruti.

The three sets of sruti nomenclatures are given on pp. 102-104 :—

TABLE VI
Sruti nomenclature
(Bharata and Sārngadeva)

Names of the Srutis.				Sapta svaras.
Tīvrā तीव्रा	Kumudvatī कुमुद्वती	Mandā मन्दा	*Chhandovatī* छन्दोवती	Shadja
	Dayāvatī दयावती	Ranjanī रञ्जनी	*Ratikā* रतिका	Rishabha
		Raudrī रौद्री	*Krodhā* क्रोधा	Gāndhāra
Vajrikā वज्रिका	Prasārinī प्रसारिणी	Prīti प्रीतिः	*Mārjanī* मार्जनी	Madhyama
Kshiti क्षितिः	Raktā रक्ता	Sandīpini सन्दीपिनी	*Alāpinī* आलापिनी	Panchama
	Madantī मदन्ती	Rohinī रोहिणी	*Ramyā* रम्या	Dhaivata
		Ugrā उग्रा	*Kshobhinī* क्षोभिणी	Nishāda

The italicised names in the above Table are the *niyata srutis* of the sapta svaras of the ancient scale *i.e.*, they were the srutis on which the suddha svaras of the ancient scale

were produced. In other words : sruti Nos. 4, 7, 9, 13, 17, 20 and 22 were the *niyata srutis*. Svaras which took other srutis were called *vikrta svaras*.

TABLE VII
Sruti nomenclature
(Nārada's *Sangita makaranda*)

Names of the Srutis.				Sapta svaras.
Siddhā सिद्धा	Prabhāvatī प्रभावती	Kāntā कान्ता	*Suprabhā* सुप्रभा	Shadja
	Sikhā शिखा	Dīptimatī दीप्तिमती	*Ugrā* उग्रा	Rishabha
		Hlādī हुलादो	*Nirvirī* निर्विरी	Gāndhāra
Dirā दिरा	Sarpasahā सर्पसहा	Kshānti क्षान्तिः	*Vibhūti* विभूतिः	Madhyama
Mālini मालिनी	Chapalā चंपला	Bālā बाला	*Sarvaratnā* सर्वरत्ना	Panchama
Sāntā शाम्ता	Vikalinī विकलिनी	*Hrdayonmalinī* हृदयोन्मलिनी		Dhaivata
	Visārinī विसारिणी	*Prasūnā* प्रसूना		Nishāda

Five Jātis are mentioned for the 22 srutis :—

दीप्ताऽऽयता च करुणा मृदुमध्येति जातयः ।

Diptā, Āyata, Karunā, Mrudu and *Madhya.*

These terms possibly signified the emotional aspects of the srutis.

Dipta = brilliant ; *Ayata* = stretched ; *Karunā* = pathetic; *Mrudu* = soft ; *Madhya* = intermediate.

Alaku (அளகு) is the name for sruti in ancient Tamil music and the 22 srutis are referred to as 22 alakus (அளகுகள்).

TABLE VIII
Sruti Nomenclature
(Bhāvabhatta's *Anupa sangita vilāsa*).

Names of the Srutis.				Sapta svaras
Nandanā	Nishkalā	Gūḍā	*Sakalā*	Shadja
नन्दना	निष्कला	गूढा	सकला	
	Madhura	Lalitha	*Kākshara*	Rishabha
	मधुर	ललित	काक्षरा	
		Bhragajāti	*Hrasvagiti*	Gāndhāra
		भ्रगजाति	ह्रस्वगीति	
Ranjika	Chāparā	Pūrnā	*Alankārinī*	Madhyamā
रंजिका	चापरा	पूर्णा	अलंकारिणी	
Vainika	Valita	Tristhānā	*Susvarā*	Panchama
वैणिका	वलिता	त्रिस्थाना	सुस्वरा	
	Saumyā	Bhāshāngikā	*Vārtikā*	Dhaivata
	सौम्या	भाषाङ्गिका	वार्तिका	
	Vyāpakā or Prasannā		*Subhagā*	Nishāda
	व्यापका	प्रसन्ना	सुभगा	

Complementary Intervals in an octave

An octave can be viewed as the sum of two intervals. The frequencies of these two intervals will be different and their sum will be equal to 2, the frequency of the octave note. Amongst these sets of complementary intervals forming an octave, the following features may be noted :—

1) If of two intervals constituting an octave, one is a samvādi interval, the other also is a samvādi interval.

For example, the intervals of Panchama and the Suddha madhyama together constitute an octave ; $\frac{3}{2} \times \frac{4}{3} = 2$ These two are samvādi intervals. They are samvādi svaras of shadja.

2) If of two intervals constituting an octave, one is an anuvādi interval, the other also is an anuvādi interval.

For example, the intervals of

(a) Chatussruti dhaivata and Komala sādhārana gandhāra $\frac{27}{16} \times \frac{32}{27} = 2$

(b) Trisruti dhaivata and sādhārana gandhāra $\frac{5}{3} \times \frac{6}{5} = 2$

(c) Dvisruti dhaivata and Antara gandhāra $\frac{8}{5} \times \frac{5}{4} = 2$

(d) Ekasruti dhaivata and Chyuta madhyama gandhāra

$$\frac{128}{81} \times \frac{81}{64} = 2$$

together constitute an octave. Thus *ga* and *dha* inclusive of their varieties are anuvādi intervals. They are anuvādi svaras in relation to shadja.

3) If of two intervals constituting an octave, one is a vivādi interval, the other also is a vivādi interval.

For example, the intervals of,

(a) Chatussruti rishabha and Komala kaisiki nishāda,
$$\frac{9}{8} \times \frac{16}{9} = 2$$

(b) Trisruti rishabha and Kaisiki nishāda
$$\frac{10}{9} \times \frac{9}{5} = 2$$

(c) Dvisruti rishabha and Kākali nishāda.
$$\frac{16}{15} \times \frac{15}{8} = 2$$

(d) Ekasruti rishabha and Tīvra Kākali nishāda.
$$\frac{256}{243} \times \frac{243}{128} = 2$$

together constitute an octave. Thus *ri* and *ni* inclusive of their varieties are vivādi intervals. They are vivādi svaras in relation to shadja.

The vivādi svaras when sounded together give a repulsive effect. The anuvādi svaras when sounded together give an effect which is neither pleasant nor repulsive. The samvādi svaras when sounded together give a pleasant effect. These are truths which hold good in all countries.

Other Srutis

With the progress of the art, a few more srutis came into use. In the lakṣhana gīta in Gundakriya rāga, ascribed to Venkatamakhi, a reference is made to 24 srutis. Subbarāma Dīkshitar however points out in the Errata that the number 24, is a misprint for 22 which cannot be reconciled (See the *Sangīta Sampradāya Pradarsini* Vol I Pp. 244 and Errata P. 6.)

In passing it may be pointed out that the advocates of the theory of 53 srutis assign 9 srutis for a chatussruti interval (major tone), 8 srutis for a trisruti interval (minor tone) and 5 srutis for a pūrna dvisruti interval (diatonic semi-tone). Thus the intervals figuring in Sankarābharana scale will according to them be :—

9	8	5	9	9	8	5	= 53
r	*g*	*m*	*p*	*d*	*n*	*s*	

An interesting 18th cent. manuscript in the Tanjore Saraswati Mahāl Library by name *Melādhikāra lakshena* (MS. No. 11604) gives the following new, intelligent and self-explanatory nomenclature for the 24 srutis :—

TABLE IX

Pūrvānga.	Uttarānga.
1. Shadja	15. Panchama
2. Prati Suddha Rishabha	16. Prati Suddha Dhaivata
3. Suddha Rishabha	17. Suddha Dhaivata
4. Prati Chatussruti Rishabha (Prati Suddha Gāndhāra)	18. Prati Chatussruti Dhaivata (Prati Suddha nishāda)
5. Chatussruti Rishabha (Suddha Gāndhāra)	19. Chatussruti Dhaivata (Suddha Nishāda)
6. Prati Sādharana Gāndhāra (Prati Shatsruti Rishabha)	20. Prati Kaisiki Nishāda (Prati Shatsruti Dhaivata)
7. Sādharana Gāndhāra (Shatsruti Rishabha)	21. Kaisiki Nishāda (Shatsruti Dhaivata)
8. Prati Antara Gāndhāra (Prati Antara Rishabha)	22. Prati Kākali Nishāda (Prati Kākali Dhaivata)
9. Antara Gāndhāra	23. Kākali Nishāda
10. Chyuta Madhyama	24. Chyuta Shādja Nishāda
11. Suddha Madhyama	
12. Aprati Madhyama	
13. Prati Madhyama	
14. Chyuta Panchama Madhyama	

From the Table on the previous page, it will be seen that the two extra srutis, are srutis, Nos. 8 and 22. These are the srutis between the Sādhārana gāndhāra and Antara gāndhāra and between the Kaisiki nishāda and Kākali nishāda. The two srutis occur in the Sāveri raga in the phrases $s\,r\,g\,r\,s$ and $p\,d\,n\,d\,p\,m\,g\,r\,s$. These two srutis do not figure in the scheme of 22.

This Manuscript is incomplete and its author too is not known. With the 24 srutis as 24 svarasthānas, the author has propounded an ingenious scheme of 4624 mela kartas. There are 136 chakras, each chakra comprising 34 melakartas $(136 \times 34 = 4624)$. For each of the four madhyama varieties there are 34 chakras or 1156 mela-kartas. The scheme though of academic interest is interesting as showing the lofty heights to which the genius of man has flown in the realm of pure musical theory.

Now that the student has become familiar with the topic of 22 srutis, the significance of Bharata's classification of svaras into: Vādi, Samvādi, Anuvādi and Vivādi will be appreciated. Vādi is the sounding note and sam-vādi is the note consonant with the vādi. A samvādi svara is separated from the vādi svara by 9 or 13 srutis i.e., it is at a Panchama sthāna or a Suddha Madhyama sthāna from the vādi svara. In other words, if the frequency of the vādi svara = 1, the frequencies of its samvādi svaras will be $\frac{3}{2}$ and $\frac{4}{3}$. Thus between the vādi svara and the samvādi svara there are either 8 or 12 srutis. When a vādi svara and its samvādi svara (either its panchama or suddha madhyama) are sounded together, the effect is pleasant and this is a universal truth. Svaras which are related to the vādi

svara as antara gāndhāra $\frac{4}{4}$ or sādhārana gāndhāra $\frac{6}{6}$ are called Anuvādi svaras. These svaras are separated from the vādi svara by 7 or 6 srutis. Svaras at an interval of 2 srutis from the vādi are vivādi to one another: these are mutually dissonant notes. The anuvādi svaras are neither so consonant nor so dissonant in relation to the vādi svara.

The vādi svara is the same as the jīva svara of a raga and is the most frequently sounded note in a raga. It contributes to the melodic entity of the raga. Vivādi svaras should never occur in succession· Such svaras will destroy the melodic beauty of the raga. *Therefore chromatic scales are unknown in Indian music·* Ragas wherein two semi-tones occur in succession are subject to vivādi dosha and lack the requisite quality of rakti.

The 40 of the 72 melakartas which take one or two of the following notes—Suddha Gāndhāra, Suddha Nishāda, Shatsruti Rishabha, or Shatsruti Dhaivata—are thus *vivā ti melas*. In those melas, the vivāditva is skilfully got over by playing one of the vivādi svaras with gamaka. *But there is no vivāditva in the case of two semi-tones occurring around shadja or panchama, since the one is a basic note and the other is a highly concordant note.* Thus $n\ s\ r$ (kākali nishāda, shadja and suddha rishabha) can occur in succession; likewise

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*Vivādi melas are the melas of the I and VII chakras, taking the suddha gandhara and the VI and XII chakras, taking the shatsruti rishabha (24 in all); and the first mela (taking the suddha nishada) and the last mela (taking the shatsruti dhaivata) of each of the remaining 8 chakras (16 melas in all) total $24 + 16 = 40$.

m p d (prati madhyama, panchama and suddha dhaivata) can occur in succession, either in the ascending order or descending order. A phrase like *P m m G* wherein the first *m* is a prati madhyama and the second *m* is a suddha madhyama and *g* is antara gāndhāra is also a good combination and occurs in some desya ragas like Hindusthān Behāg.

Modal Shift of Tonic.

The scheme of 22 srutis · helped the ancient scholars to discover new melas. Thus when a svara of the suddha scale was made to *lose* one sruti *i.e*, was flattened by once sruti or was made to *gain* one sruti *i.e.,* was sharpened by one sruti, a new mela resulted. Some interesting melas were thus arrived at by the process of taking away or adding one or two srutis to the notes of the suddha mela.

Another process by which new melas were discovered was the *Modal Shift of .Tonic*. The tonic note or the ādhāra shadja was shifted from note to note and when the self-same notes of the original suddha scale were played with the new notes as shadja, different scales resulted. It is common knowledge that when the Rishabha of Sankarābharana is taken as shadja and the same Sankarābharana svaras played, Kharaharapriya results. This happens on account of the re-distribution of the intervals amongst the sapta svaras consequent on the shifting of the shadja. Likewise Sankarābharana's *ga* as shadja gives Todi; its *ma* as shadja gives Kalyāni; its *pa* as shadja gives Harikāmbhoji; and its *dha* as shadja gives Nata bhairavi and so on. The *chaturdasa murchhanas* referred to in Chapter IV were derived by the process of

modal shift of tonic. Modal shift of tonic is referred to variously as the process of *graha bhedam; sruti bhedam* and *graha svara bhedam.*

The process of Modal shift of tonic can ·be applied easily to regularly symmetrical ragas like Sankarābharana, Srīranjani and Mohana *i. e.,* ragas whose ārohana and avarohana are exactly alike and possess the same svaras. It may be applied and results worked out with some effort to vakra ragas and apparently symmetrical ragas like Mayūradhvani (*s r m p n s — s n d m r s*). It is an axiomatic truth that in this process, a sampūrna raga will yield only a sampūrna raga, a shādava raga will yield only a shādava raga, and an audava raga only an audava raga. A few familiar examples are given below :—

Mohana's	*Ri*	as Shadja results in	Madhyamāvati
,,	*Ga*	,,	Mālkaus
,,	*Pa*	,,	Suddha Sāveri
,,	*Dha*	,,	Udayaravi Chandrika or Suddha dhanyāsi
Hamsadhvani's	*Pa*	,,	Nāgasvarāvali
Nāgasvarāvali's	*Ma*	,,	Hamsadhvani
Kiravani's	*Ma*	,,	Hemavati
,,	*Pa*	,,	Vakulābharanam

The process of modal shift of tonic when applied to varja ragas will yield many startlingly new ragas hitherto not thought of.

For practically solving problems relating to modal shift of tonic, the student may get hold of a Jalatarangam set and tune the cups correctly to the starting scale for a compass of two octaves. The svarasthanas of the starting scale might also be marked on the Vina finger-board and the instrument utilised for experimentally solving the problems relating to modal shift of tonic.

With the instrument *Mode-shift-ion* or *Graha bheda Pradarsini* devised by the author of this book, any problem relating to modal shift of tonic can be easily worked out and the resulting raga heard and also seen visually (See also chapter **V** of South Indian Music : Book V)

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Scales of Equal Temperament and Just Intonation

Temperament means tuning. In the *scale of equal temperament*, the sthāyi is divided into twelve equal intervals or semi-tones with the necessary consequence that the frequencies of some of the svaras are either slightly below or above their true ratios. In the *scale of just intonation*, the notes are exactly true to their pitch *i.e.*, these notes are the acoustically correct intervals. This latter scale is the ideal scale. It is also referred to as the *scale of correct intonation, pure intonation, true intonation* and *unequal temperament.* In the scale of just intonation, all the consonant intervals are perfect. Equal temperament is a compromise between the acoustically correct intervals and those required in practical music (European). The successive notes here form a perfect geometrical progression and are separated

from their neighbours by the same common interval. Of the twelve notes of the sthāyi in this scale, any two adjacent notes bear the ratio $1 : 1.05946$. The equi-tempered semi-tone becomes equal to 1.0594. The equi-tempered scale offers an advantage to players of key-board and fixed-toned instruments, since they are able to perform music on any key (sruti). In such instruments, with the exception of the shadja and its octave, the other notes are not truly consonant. When violinists perform solo, they play in the scale of just intonation. Likewise for the performers of wind instruments, the presence of keys is not an impediment. By involuntary adjustments in blowing, they perform in the scale of just intonation.

In India, all music is performed on one key (ādhāra shadja) and hence the scale of just intonation is in vogue here.

In this connection, the unsuitability of the harmonium for playing classical Indian music might be pointed out. Not only is it *not tuned* to the scale of just intonation, but there is no provision in it, for the playing of gamakas and the subtle srutis.

Western musicians have so long been accustomed to the artificial scale of equal temperament that they cannot easily appreciate the subtle beauty underlying the natural tones used in Indian music.

The Table on the next page will give an idea of the variations in the frequencies of notes in the two scales.

TABLE X

Sankarabharana

Just Intonation

	s	r	g	m	p	d	n	s
	1	1·125	1·250	1 333	1·500	1·687	1·875	2
	240	270	300	320	360	405	450	480
Value in cents	0	204	386	498	702	906	1088	1200

Equi-tempered scale

	s	r	g	m	p	d	n	s
	1	1·122	1·260	1·335	1·498	1·682	1·888	2
	240	269·4	302·4	320·4	359·4	403·4	453·4	480
Value in cents	0	200	400	500	700	900	1100	1200