A KARNATIC MUSIC PRIMER

P. Sriram

ABOUT THE AUTHOR

Dr. Parthasarathy Sriram, is an aerospace engineer, with a bachelor's degree from IIT, Madras (1982) and a Ph.D. from Georgia Institute of Technology where is currently a research engineer in the Dept. of Aerospace Engineering. The preface written by Dr. Sriram speaks of why he wrote this monograph. At present Dr. Sriram is looking after the affairs of the provisionally recognized South Eastern chapter of the Carnatic Music Association of North America in Atlanta, Georgia. CMANA is very privileged to publish this scientific approach to Carnatic Music written by a young student of music.

Table of Contents

Preface

Om Sri Gurubhyo Namaha.

This booklet is aimed at music lovers everywhere who wish to learn a little bit about the basic theory of Carnatic music. There are a large number of books on many aspects of Carnatic music but I have found most of them to be of an advanced nature - they have lots of good information but it is extremely difficult for a novice to start learning about music using them. Once the basics are mastered, these books provide enormous scope for intellectual enrichment. This opinion is shared by many of my music loving friends as evidenced by their expressing a need for a simple booklet such as this one. The primary motivation in producing this booklet was to put together the basics in one place so that a beginner can get started off easily. Except for the section on Grahabedam and Symmetries, there is very little new material contained herein. The following books have been consulted to obtain much of the material and interested readers are encouraged to further their knowledge by reading them.

The New Groves Dictionary of Music and Musicians, under 'India.'
Sri Krithi Mani Malai by R. Rangaramanuja Iyengar, 4 volumes.
Ganamrutha Varna Malika by A. S. Panchapakesa Iyer.
Abhyaasa Gaanam by A. Sundaram Iyer.
Karnataka Sangeetham by A. Sundaram Iyer.
Karnataka Sangeetham by Prof. P. Sambamoorthy, 3 volumes.

This book is intended to be read through (perhaps several times) and it is inadvisable to delve into the later sections without reading through the earlier sections. Most of the terminology is originally in Sanskrit and I have made no attempt to use a standard transliteration scheme eg. Carnatic and Karnatic are both used. In fact, I have mixed Tamil and Sanskrit terms freely (raga, ragas and ragams can all be found in the text) and hope it is not a nuisance. I have assumed little more than an interest in Carnatic music on the part of the reader and thus, the initial sections deal with basics like swaras, their names etc. Being a scientist and an engineer, I was tempted to include mathematical ideas wherever possible. Further, it is very difficult to present anything other than an analytical approach in a book like this. Nevertheless, most of the mathematical and physical concepts used are elementary and are no more advanced than what one would encounter in high school.

A few words of advice to readers: Listen to as much music as you can and find friends who share your interest. Discuss what you know and you will almost always end up adding to your knowledge. There is no question that is so silly that it does not deserve to be asked. The art of identifying ragas cannot be learned from a book and it usually takes years of listening before one begins to identify ragas reliably. Patience and perseverance are the key words here.

Inspiration for this work was provided by my uncle Valavanur N. Jambunathan (who was born of parents who were neither musicians nor musicologists and who did not have the benefit of any musical education, whatsoever), who is our family musical resource. Further encouragement was provided by my cousins, especially Basu (S. Baskaran, Dubai, U.A.E.), and many others who expressed interest in a document such as this. Special thanks are due to my 'brothers' of the Atlanta Panchapandavas, Drs. Mahadevan (Nashville, Tennessee), Gajanan (Knoxville, Tennessee), Chander (Washington, D.C.) and Kannan (Philadelphia, Pennsylvania) for aiding me in my discovery of love for classical music and (especially to Mahadevan) for reviewing and contributing to the material in this book.

This work is dedicated to my Gurus Sri. Prathapam Natesa Iyer (disciple of Ariyakkudi Ramanujam Iyengar) and Smt. Jayalakshmi Ramaswamy (disciple of G.N. Balasubramanian). Anything good you see in this book is a consequence of the musical knowledge they instilled in me while the errors you may come across are entirely due to my inability to comprehend what I was taught.

I sincerely hope that reading this book accelerates your understanding and appreciation of music. This document is by no means perfect and I welcome all suggestions and comments.

P. Sriram

Atlanta, U.S.A.

February 1989.

Introduction

"Nature has endowed this universe with many beautiful life forms, of so many different shapes, sizes and abilities. Most animal forms have the ability to produce sounds and some of them even have the capability to communicate using varied sounds. Man is unique in that he can express his thoughts using sound." This is how Swami Jayendra Saraswathy (Sankaracharya of Kanchipuram) introduces the Kamalaambaa Navaavarna Kritis of Muthuswamy Dikshithar. The ability to express thoughts through sounds has evolved into an art which we call music. Music can thus be defined as an art form that arranges sounds in a fashion that follows certain natural principles and provides that special inner feeling of happiness and contentment. It is important to note that the basic principles are natural and thus the theory of music is only an attempt by man to rationally explain what is already beautiful. As a fringe benefit, this rationalization helps in understanding the inherent beauty of music and creates increasingly higher levels of appreciation in the listener.

The most basic unit of music is the swara (or note) which simply indicates the position in the audible spectrum occupied by a particular sound or the pitch of the sound. Actually, the spectral position is better described as swara sthana. Inherently, certain sounds 'go together' and certain others do not. This property was realized by man thousands of years ago and is indicated by the term harmony; lack of harmony is called disharmony. Before going any further, let me introduce, as a practical tool, a keyboard, that will help us immensely as we go along deeper into the fundamentals of Carnatic music. Purists may frown at this, but as long as we realize the limitations of the keyboard and why the purists frown, we are committing no sin.

At first glance, a keyboard is simply an assortment of black and white keys of two different lengths, usually the black keys being the short ones. A closer examination shows a pattern of keys repeating a few times to produce the full keyboard. The repeating pattern is shown in the following figure. Many keyboards indicate the location of the 'C' key as shown in the figure. In any case, a C key can be identified as the white (or long) key immediately to the left of a group of two black keys or the first key in the above figure. Evidently, there is more than one C key (perhaps 4 or even more) on the keyboard. The C key is so called due to the notation used in western music for the notes. The successive white keys to the right of C are labeled D, E, F, G, A and B. As a first example of harmony, play a C key and the next C key simultaneously and listen carefully[+]. The combined sound has an oneness. Playing a C key and the white key next to it (the D key) does not produce a similar effect and the two tones stand out separately. They do not merge as in the case of the two C keys. Total disharmony is difficult to demonstrate using a keyboard due to the discrete nature of the notes that can be played. One would have to produce a sound that is located 'between' two keys in order to hear a set of highly disharmonious (abaswara) notes but the preceding demonstration is a simple example of two levels of harmony.

Keyboard Layout
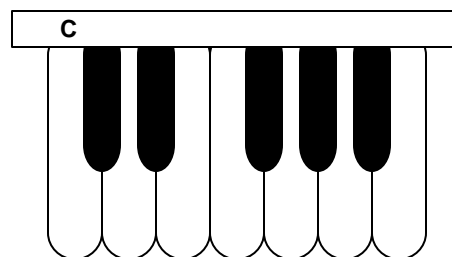
[+]It is assumed here that the keyboard is polyphonic i.e., has the ability to produce more than one tone at a time. Many inexpensive keyboards lack this ability and are not suitable for this demonstration.

Two successive C keys are separated by what is called an octave which corresponds to a ratio of two in frequency. That is, the frequency of a C note is exactly double the frequency of the C immediately below (to the left of) it and exactly half the frequency of the C immediately above it. Two sounds are perceived to be very similar if they are separated by an octave and the only explanation for this is that that is how mother nature has made it!

The concept of harmony is closely related to the notion of harmonics. Consider a string fixed at both ends and vibrating at a fundamental frequency f. From basic physics, the upper harmonics of the string are at integral multiples of f, namely, $2f$, $3f$, $4f$ etc. Harmonious tones have common harmonics and this implies that the tones have fundamental frequencies that are related as a ratio of two integers. A high degree of harmony is associated with ratios involving powers of 2 (2:1, 4:1, 8:1 etc.) and small integers (eg. 3:2). The ratio 3:2 signifies that the second harmonic of the higher frequency tone coincides the third harmonic of the lower frequency tone and such a relationship is very easily detected by the human ear. Two tones related through a ratio 91:85 are not perceived as being very harmonious because the common harmonics are the 91st and 85th. Such high harmonics typically have very low intensity and may even be beyond the frequency range of the human ear. The principle of integral ratios is inherent in our perception of sound. A tune is identified by the ratio of frequencies that appear in succession to produce it and only special training develops the ability to perceive the absolute pitch (frequency) of sounds.

Next we observe that there are a total of twelve keys in the repeating pattern (or twelve swara sthanas in an octave). This division of an octave into twelve swara sthanas has evolved over a period of millennia. This is evident from the fact that while some ancient forms of music use fewer swara sthanas, the current forms of many styles of classical music which evolved independently (including Western, Hindustani and Carnatic) use only twelve swara sthanas to an octave. In ancient Vedic chantings, we have only three swara sthanas, denoted as normal, low and high. Interestingly, the pitch steps corresponding to these three swara sthanas can be represented by the F, G and A keys. Vedic chants of later periods use as many as seven swaras and are often described as the precursors of the raga system. The twelve swara sthanas are generally considered to be the maximum number of sthanas that a normal human ear can perceive to be different without too much difficulty.

Western music believes in specifying the absolute pitch of all swaras and thus, the frequencies of all keys are fixed and the same for all keyboards (in fact, all instruments, if one can locate the corresponding notes). Indian music is based on relative positioning and thus, notes are not of fixed pitch. The note Sa is the analog of the note C. The white key marked C is called as one kattai and the successive white keys are assigned values of two kattais, three kattais and so on. The black keys are assigned fractional values (one and a half, two and half and so on). Note that there is no three and a half kattai pitch. The sruthi accompaniment (tampoora or sruthi box) provides the reference pitch and we indicate the reference pitch by saying that somebody sings at one and half kattai pitch, or a veena is tuned to four and half kattais. This simply means that the Sa has been set to that pitch and all other swaras occupy corresponding sthanas. The importance of the Sa is that it provides the fixed foundation note upon which the rest of the music is built. Such a foundation note exists in classical Western music also and is indicated by the scale name eg. F-Major indicates that the tune is built using F as the base note. The base note can be discriminated with a little practice since the music generally returns to dwell on the base note every now and then.

Swaras and Swarasthanas

There are seven swaras in Carnatic music, namely, Shadjam (Sa), Rishabam (Ri), Gandharam (Ga), Madhyamam (Ma), Panchamam (Pa), Dhaivatham (Da) and Nishadam (Ni). There is some theoretical basis for why there is an odd number (seven) of swaras and we will deal with this subsequently. For simplicity, let us fix the Sa at one kattai and place the remaining swaras at the successive white keys. This provides us with a scale or a raga (in this case, containing all the seven swaras). As mentioned previously, ancient Vedic chants have but three swaras and somewhat later forms of music (Indian as well as other forms, eg. Chinese) use five swaras - eg. the Sa, Ri, Ga, Pa and Da of the scale we just created. Our present system is based on seven swaras, and perhaps, a few thousand years from now, the human race will advance to a point of discriminating scales of more swaras (unlikely). The seven swaras are mythologically associated with the sounds produced by certain animals and the names of the swaras are related to the names of these animals. The name Madhyamam appears to be related to the central or madhya location in the seven notes and Panchamam is most probably derived from the number five, denoting the position of the note.

We observed earlier that doubling the pitch of a swara by a factor of two results in going up in pitch by one octave. Thus, doubling the pitch of Sa (say Sa^1) results in another Sa (Sa^2) which is one octave higher than our original Sa. A further doubling produces Sa^3 which is one octave higher than Sa^2 and two octaves above Sa^1. Three times the original Sa produces the Pa located between Sa^2 and Sa^3. In other words, the pitch of the swara Pa is one and half times the pitch of the Sa below it (and three fourths the pitch of the Sa above it). Now we come to an important limitation of the keyboard - the way the octave is divided into the twelve swara sthanas. Since it is based on current western music norms, the division is done on a logarithmic basis (which is just a more technical way of saying that the pitch values of the successive swara sthanas form a geometric progression). An octave is a factor of two and there are twelve intervals in it. If we make all the intervals equal to a multiplicative factor x, then the pitch corresponding to any key will be x times the pitch of the key (white or black) immediately to the left of it. Extending the procedure we arrive at what the value of x should be. The thirteenth swara sthana results in an octave, or, stated mathematically, $x^{12}=2$. Then, we have x to be the twelfth root of two or a factor of approximately 1.06. Using this logarthmic division procedure, Pa (the 8th swara sthana) corresponds not to a ratio of 1.5 but 1.498. Though the discrepancy is very small, a well trained ear (eg. professional musician) can pick out this difference.

Carnatic music is based not on logarithmic division but on rational division. An octave is based on the ratio 1:2; Pa is located through the ratio 2:3; similar definitions exist for all the twelve swara sthanas. A few centuries ago, Western classical music too was based on rational division (the resulting scale was called as the natural scale), but this has given way to the equally tempered (also called chromatic) scale produced by logarithmic division. The difference is subtle, but quite important. The rational division claim is supported by the fact that tuning of instruments (for example, in setting the frets of veena) is performed mostly by the ear and not by reference to standards. Further, the swara sthanas of Carnatic music define only nominal locations for the swaras. Depending on the raga in which the swara is used, it manifests a deviation from the nominal sthana. Actually, the deviation from the nominal sthana depends on the swara phrase in which the swara occurs; thus, a single swara in a given raga can appear at different deviations from its nominal sthana when occuring along with various other swaras of the same raga. In a general sense, this deviation is called gamaka. Gamaka can refer to a constant deviation from the nominal swara sthana or a time dependent deviation or the path taken in reaching the nominal swara etc. Truly, gamaka is the life blood of Carnatic music and the raga system. Ragas are defined more by the gamakas and the way in which certain swara phrases (chain of swaras) are used than by the mere presence or absence of certain swaras. Thus, playing the keys corresponding to the swara sthanas of a certain raga will not reproduce the true character of the

raga but only provide a general idea of what it sounds like. This is the reason why purists object to the use of keyboard instruments in Carnatic music - the lack of gamaka, which leads to a mutilation of the raga swaroopa. The use of gamaka also implies that the method used for defining nominal swara sthanas (rational or logarithmic division) is not too critical as long the correct raga swaroopam can be accommodated.

In the past, Hindustani music also had complex gamaka schemes, but the acceptance of the Harmonium has caused their virtual disappearance and only a few of the gamakas remain in use. The result is that the current form of Hindustani music has lost some of its traditional character - perhaps forever. Carnatic music is one of the very few musical forms in the world that have not lost their traditional character due to the influence of western culture. On the contrary, Carnatic music has enhanced its traditional character by borrowing good things from other systems of music. The introduction of the violin is a very good example of a positive influence. The instrument and its playing techniques have been successfully adapted to fit in with the rest of the system. This adaptation is so complete that the present day listener can hardly imagine a concert without a violin accompanying the singer.

The seven basic swaras occupy various swara sthanas and produce a total of sixteen swaras that form the basis of the raga scheme. It should be emphasized that the swara sthanas are nominal and in actual usage, depending on the raga, the swara is not fixed at any one sthana but appears at various locations around a nominal swara sthana in different swara phrases. The Shadja and Panchama swaras are like the foundations upon which the rest of the melody is constructed. So, these occupy fixed sthanas. This is denoted by naming these swaras as Prakruthi swaras (all the other swaras are grouped under Vikruthi swaras). Further, these two swaras are usually employed without any gamakas. In order to identify the sthanas of the various swaras, let us number the twelve sthanas. The names of the swaras and the swara sthanas they occupy are given in the following table.

Numbered sthana	Name	Notation/Common name
1	Shadjam	Sa
2	Suddha Rishabam	Ra, Small Ri
3	Chatusruthi Rishabam	Ri, Big Ri
	Suddha Gandharam	Ga
4	Shatsruthi Rishabam	Ru
	Sadharana Gandharam	Gi, Small Ga
5	Anthara Gandharam	Gu, Big Ga
6	Suddha Madhyamam	Ma, Small Ma
7	Prati Madhyamam	Mi, Big Ma
8	Panchamam	Pa
9	Suddha Dhaivatham	Da,Small Da
10	Chatusruthi Dhaivatham	Di, Big Da
	Suddha Nishadam	Na
11	Shatsruthi Dhaivatham	Du
	Kaisika Nishadham	Ni, Small Ni
12	Kakali Nishadham	Nu, Big Ni

The numbering used above allows one to easily locate the swaras on fretted string instruments (veena, mandolin etc.). One simply counts up the frets till the desired swara is reached. For example, if a Sa is played on a

particular fret, to get a Prati Madhyamam, one simply moves up 6 frets on the same string (moving six steps from 1 results in 7, the number denoting the Prati Madhyamam). The Ra-Ri-Ru notation exists chiefly for convenience and is not used very widely. In conformance with that practice, this document will point out when the notation is being used. In the absence of such an indication, Ra should be taken to imply not Suddha Rishabam but a generic Rishabam. The following keyboard diagrams show the locations of the swaras for one kattai and four and a half kattai reference pitch using the ra-ri-ru notation. A similar indication can be easily made up for fretted string instruments simply by using the swara sthana table and counting up the frets starting from Sa.

The use of sixteen swara names has led to some people describing an octave as being divided into more than twelve swara sthanas (as many as twenty two). But, as the table and keyboard diagrams show, there are only twelve sthanas and certain pairs of swaras occupy the same nominal swara sthana (eg. Chatusruthi Rishabam and Suddha Gandharam). In an earlier era (or for that matter, in contemporary Hindustani music), the duplicate name swaras were not used i.e. each swara sthanam was associated with one and only one swaram. The swaras of the octave then read (in Ra-Ri-Ru notation) Sa - Ra - Ri - Gi - Gu - Ma - Mi - Pa - Da - Di - Ni - Nu - Sa. The remaining swaras, Ru, Ga, Du and Na, were considered to be tainted ('Dhosham') and their use was to be avoided. These four swaras are called as Vivadi swaras and their use is now generally accepted. The occurrence of combinations of swaras gives rise to melodies which can then be classified on the basis of the swaras that are used. This leads to the scheme of ragas which is our next topic of discussion.

Swaras for one kattai reference pitch
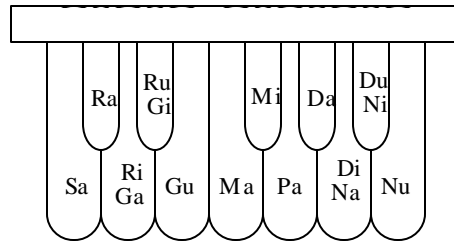
Swaras for four and half kattai reference pitch
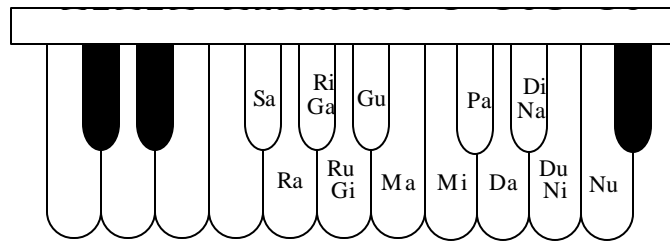
Ragas

Ragas are sometimes defined as melody types. The raga system is a method of organizing tunes based on certain natural principles. Tunes in the same raga use the same (nominal) swaras in various combinations and with practice, the listener can pick up the similarity. Each raga has a swaroopam (a musical form or image) that is defined by the swaras used, the gamakas given to these swaras, the sequence in which the swaras occur etc. This definition is termed as the raga lakshanam[*]. Raga lakshanam usually contains the arohanam, avarohanam, details of raga chaya swaras (the swaras which are chiefly responsible for the characteristic melody of the raga), gamakas, characteristic swara phrases and general usage notes. It is intended more for the performer than for the listener. We shall first define arohanam and avarohanam. Arohanam is the sequence of swaras used in a raga in the ascending passages i.e. as the pitch goes up. Avarohanam is the sequence of swaras to be used in descent. The arohanam and avarohanam (or the scale) of a raga provide only a skeletal outline upon which the rest of the raga is formed.

Ragas are not simply abstract collections of swaras that occur together to produce a tune. Each raga has a distinct image or swaroopam and it is this which defines a raga. Arbitrary selection of a set of swaras is unlikely to produce a distinct raga swaroopam and this is the reason for attributing the foundations of the raga system to nature. The ragas that we know of are the products of centuries of experimentation. Each ragam has associated with it a feeling that it induces in the listener and the performer. Hours of dedicated practice with a single raga (Saathakam) results in the realization of the raga swaroopa on the part of the performer and this is often referred to as obtaining a Dharshan of that particular raga. The unfortunate consequence of this is that various performers have slightly different mental concepts of a single raga and this is manifest in their music. But the good part is that it adds a tremendous variety to the music. This is also the reason why Carnatic music (performance) can never really be learnt from a book but needs a Guru who can portray the raga swaroopam in such a manner that the pupil can pick it up. From the viewpoint of the listener, a realization of the raga swaroopam means that some of the qualities of the music can be anticipated and this contributes greatly to listening pleasure.

Ragas fall into two types, the base or melakarta ragas and the derived or janya ragas. Melakarta ragas have a formal structure and follow a fairly rigid scheme of scientific organization whereas the janya ragas are rooted in usage and are liable to evolve with the music. In fact many janya ragas change their character over time. Janya ragas are derived from the melakarta ragas through various means as described subsequently. Melakarta ragas are identified by the fact that they use all seven swaras and the arohanam and avarohanam are always Sa-Ri-Ga-Ma-Pa-Da-Ni-Sa and Sa-Ni-Da-Pa-Ma-Ga-Ri-Sa. This type of arohanam and avarohanam is denoted by the term sampoornam, indicating completeness. The existence of multiple swara sthanas for Ri, Ga, Ma, Da and Ni implies that by collecting combinations of these, we can form a system of melakartas. This concept will be developed in the succeeding section. Any raga that does not belong to the melakarta system is a janya raga. Janya ragas are characterized by missing notes in the arohanam and/or avarohanam (eg. Sa-Ri-Ga-Pa-Da-Sa), the use of twisted progressions (eg. Sa-Ga-Ri-Ma-Pa-Da-Ni-Sa) etc. Janya ragas and their classifications will be described subsequently.

The definition of melakarta given above is a currently accepted one. In the past, melakartas have been defined in other ways, sometimes incompatible with the sampoornam characteristic. The present system is mathematically much more elegant and that appears to be one of the reasons for its wide spread acceptance and use in the past few centuries.

---

[*]The magazine Sruthi usually contains a discussion of ragalakshanam of one or two ragas in each issue.

The Melakarta Scheme

Contemporary Carnatic music is based on a system of 72 melakarta ragas. These 'creator' ragas are also called janaka ragas and thai (mother) ragas. The current system can be traced to the works of Venkatamakhi who appears to be the first to use 72 melakartas. Earlier works generally contain fewer melakartas and most have flaws in organization. At that time, (16th century) many of Venkatamakhi's melakartas were unknown and were not assigned names. Later, all 72 were given names and this system is sometimes referred to as the Kanakaambari - Phenadhyuthi system after the names of the first two melakartas in it. Muthuswamy Dikshithar's compositions are generally based on the raga names and lakshanams (definitions) in this system while Thyagaraja used a later scheme devised by Govindacharya in the late 18th century. Venkatamakhi did not believe that melakartas must be of simple sampoorna arohanam - avarohanam but favored the idea of calling a raga as a melakarta if all the seven swaras occurred in either the arohanam or the avarohanam. Thus a raga which went Sa-Ri-Ma-Pa-Ni-Sa, Sa-Da-Pa-Ga-Ri-Sa could be a melakarta under this scheme. Govindacharya's insistence on sampoorna arohanam - avarohanam leads to a system which is more elegant from a mathematical viewpoint. In this scheme, the melakartas arise out of systematic permutation of the seven swaras into the twelve swara sthanas. Seen this way, the melakarta scheme is a product of mathematical abstraction and the naming of swaras (and the introduction of vivadi swaras) is of no consequence as far as the organization of the melakartas is concerned. No wonder, Venkatamakhi is reputed to have said that even Lord Maheswara could not create more melakartas!

As we noted before, all melakartas employ a complete (sampoornam) arohanam-avarohanam structure. The purvangam of a melakarta refers to the lower half of the Arohanam-Avarohanam, namely Sa-Ri-Ga-Ma and uttarangam refers to the upper half or Pa-Da-Ni-Sa. First let us examine the possible variations in the uttarangam. Pa is fixed. Da can occupy three sthanas and so can the Ni. But, the Ni has to be always above the Da and that leaves us with the following six possible uttarangams.

(1)   Pa-Suddha Dhaivatham-Suddha Nishadam-Sa

(2)   Pa-Suddha Dhaivatham-Kaisika Nishadam-Sa

(3)   Pa-Suddha Dhaivatham-Kakali Nishadam-Sa

(4)   Pa-Chatusruthi Dhaivatham-Kaisika Nishadam-Sa

(Suddha Nishadam occupies the same swara sthana as Chatusruthi Dhaivatham and hence the two cannot occur together)

(5)   Pa-Chatusruthi Dhaivatham-Kakali Nishadam-Sa

(6)   Pa-Shatsruthi Dhaivatham-Kakali Nishadam-Sa

These six uttarangam combinations are denoted by the names Pa, Sri, Go, Bhu, Ma and Sha respectively. The following series of figures illustrate the keyboard locations of the swaras in these six uttarangam combinations as also the corresponding numbered swara sthanams (the number 13 refers to the Sa of the next octave) for one kattai sruthi.
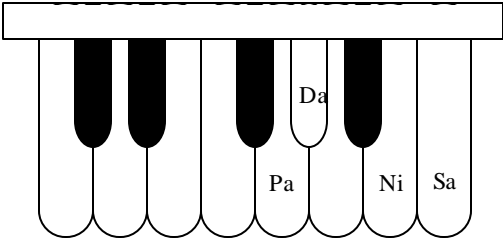
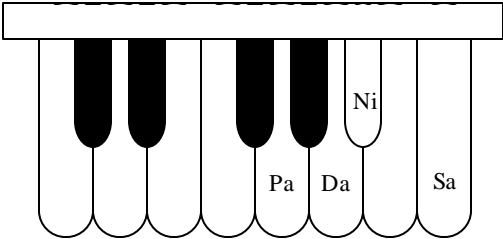Swara Locations for the 'Pa' uttarangam (8-9-10-13)

Da

Pa   Ni   Sa
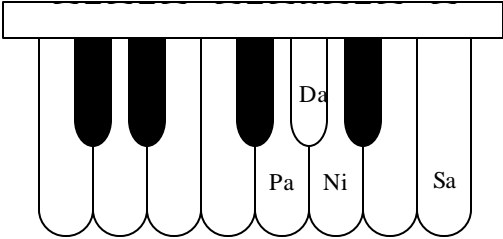
Swara Locations for the 'Sri' uttarangam (8-9-11-13)

Da   Ni

Pa   Sa
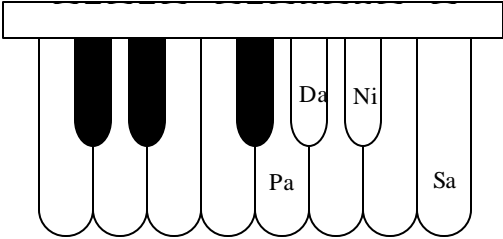
Swara Locations for the 'Go' uttarangam (8-9-12-13)

Da

Pa   Ni   Sa

Swara Locations for the 'Bhu' uttarangam (8-10-11-13)

Ni

Pa   Da   Sa

Swara Locations for the 'Ma' uttarangam (8-10-12-13)

Pa   Da   Ni   Sa
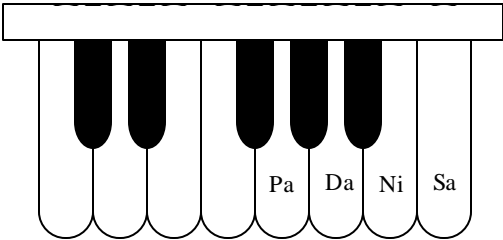
Swara Locations for the 'Sha' uttarangam (8-11-12-13)

Da

Pa   Ni   Sa
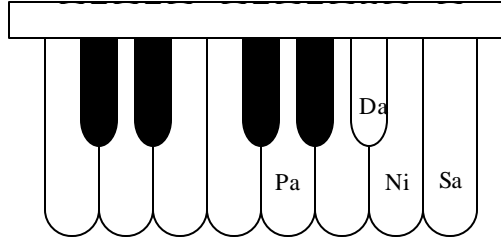
As in the case of the Da and Ni uttarangam combinations, the Ri and Ga provide six possible combinations. Each of these can occur with either of the two Madhyamams to yield a total of twelve possible purvangams. The twelve purvangam combinations are each called as chakras. The twelve chakras and the corresponding purvangams are as follows.

(1)   Indu   Sa, Suddha Rishabam, Suddha Gandharam, Suddha Madhyamam
(2)   Netra   Sa, Suddha Rishabam, Sadharana Gandharam, Suddha Ma
(3)   Agni   Sa, Suddha Rishabam, Anthara Gandharam, Suddha Ma
(4)   Veda   Sa, Chatusruthi Rishabam, Sadharana Gandharam, Suddha Ma
(5)   Bana   Sa, Chatusruthi Rishabam, Anthara Gandharam, Suddha Ma
(6)   Ruthu   Sa, Shatsruthi Rishabam, Anthara Gandharam, Suddha Ma
(7)   Rishi   Sa, Suddha Rishabam, Suddha Gandharam, Prati Madhyamam
(8)   Vasu   Sa, Suddha Rishabam, Sadharana Gandharam, Prati Ma
(9)   Brahma   Sa, Suddha Rishabam, Anthara Gandharam, Prati Ma
(10) Disi   Sa, Chatusruthi Rishabam, Sadharana Gandharam, Prati Ma
(11) Rudra   Sa, Chatusruthi Rishabam, Anthara Gandharam, Prati Ma
(12) Aditya   Sa, Shatsruthi Rishabam, Anthara Gandharam, Prati Ma

The chakra names are associated with the chakra numbers they represent. For example, there are four Vedas, and Veda chakra is the fourth chakra. The following illustrations depict the swara locations on the keyboard for the twelve chakras, along with the numbered swaras.

Swaras of Indu Chakra (1-2-3-6)

Ri

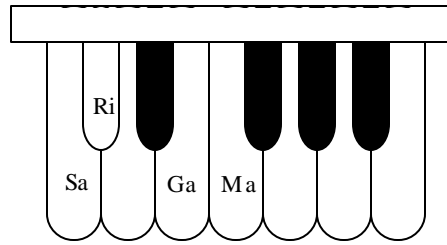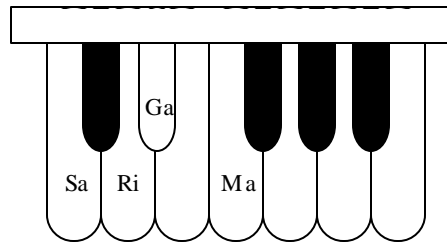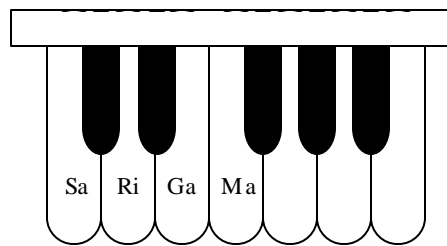Sa   Ga   Ma
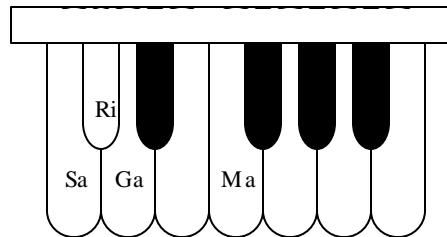
Swaras of Netra Chakra (1-2-4-6)
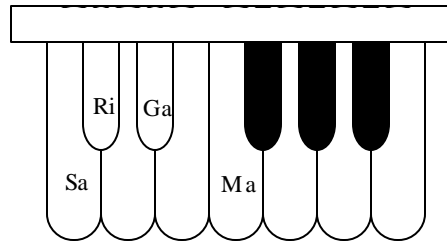
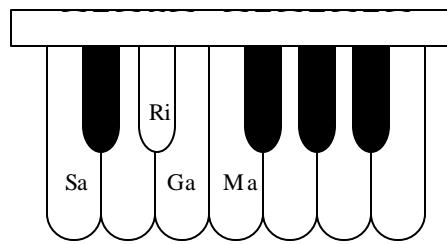Swaras of Agni Chakra (1-2-5-6)

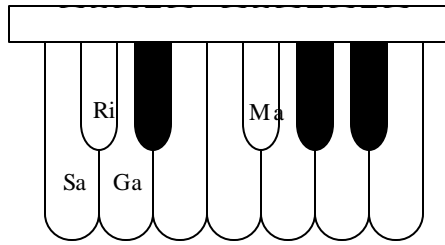Swaras of Veda Chakra (1-3-4-6)
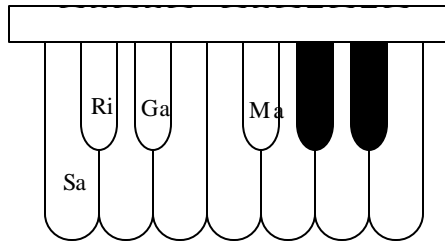

Swaras of Bana Chakra (1-3-5-6)
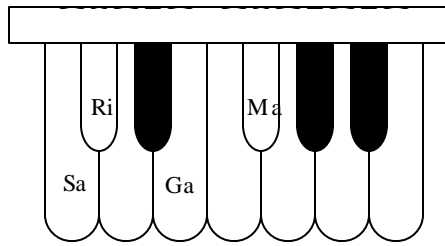

Swaras of Ruthu Chakra (1-4-5-6)
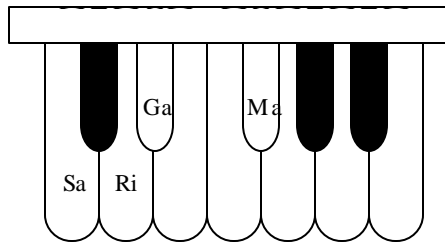
Swaras of Rishi Chakra (1-2-3-7)

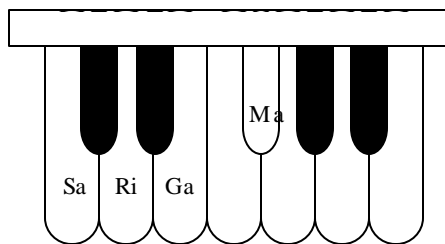Swaras of Vasu Chakra (1-2-4-7)

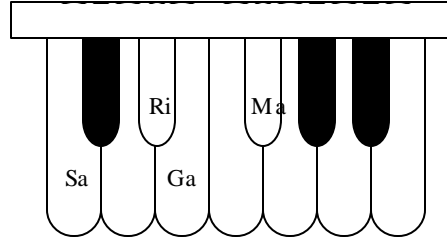Swaras of Brahma Chakra (1-2-5-7)

Swaras of Disi Chakra (1-3-4-7)

Swaras of Rudra Chakra (1-3-5-7)

Swaras of Aditya Chakra (1-4-5-7)

Each of the twelve purvangams can be combined with the six uttarangams to obtain a total of 72 melakartas. The melakartas are then identified by combining the chakra name with the Pa - Sri designation. Thus, a melakarta described as Rudra-Ma (or no. 65, Mechakalyaani) corresponds to an arohanam and avarohanam containing Shadjam - Chatusruthi Rishabam - Anthara Gandharam - Prati Madhyamam - Panchamam - Chatusruthi Dhaivatham - Kakali Nishadam - Shadjam. The following table lists all the 72 melakartas and the swaras used in each of them using the chakra and Pa - Sri notation as described. The first 36 melakartas use Suddha Madhyamam and melakartas 37 through 72 use Prati Madhyamam. These two groups are sometimes identified as Suddha Madhyama melakartas or Purva melakartas and Prati Madhyama melakartas or Uttara melakartas respectively. The table is organized in such a fashion that a Suddha Madhyama melakarta and its Prati Madhyama pair (the melakarta which shares all swaras except the Madhyama) occur on the same line. Thus to find out what is the Prati Madhyama (or Uttara melakarta) pair of Maayaamaalavagowla, one just reads across the table to find Kaamavardhani (which is also known as Pantuvaraali). If it were not for the gamakkas, such pairs would sound very similar and be different only when the Madhyama occurs.

Melakarta Ragas

No.	Name				Name	No.
1	Kanakaangi		Pa	R	Saalakam	37
2	Rathnaangi	I	Sri	I	Jalaarnavam	38
3	Gaanamurthy	N	Go	S	Jhaalavaraali	39
4	Vanaspathy	D	Bhu	H	Navaneetham	40
5	Maanavathy	U	Ma	I	Paavani	41
6	Taanaroopi		Sha		Raghupriya	42
7	Senaavathy	N	Pa		Gavaambhodhi	43
8	Hanumathodi	E	Sri	V	Bhavapriya	44
9	Dhenuka	T	Go	A	Subhapantuvaraali	45
10	Naatakapriya	R	Bhu	S	Shadvidhamaargini	46
11	Kokilapriya	A	Ma	U	Suvarnaangi	47
12	Roopavathy		Sha		Divyamani	48
13	Gaayagapriya		Pa	B	Dhavalaambari	49
14	Vakulaabharanam	A	Sri	R	Naamanaaraayani	50
15	Maayaamaalavagowla	G	Go	A	Kaamavardhani	51
16	Chakravaaham	N	Bhu	H	Raamapriya	52
17	Sooryakaantham	I	Ma	M	Gamanasrama	53
18	Haatakaambari		Sha	A	Visvambari	54
19	Jhankaaradhwani		Pa		Shyaamalaangi	55
20	Natabhairavi	V	Sri	D	Shanmugapriya	56
21	Kiravaani	E	Go	I	Simhendramadhyamam	57
22	Kharaharapriyaa	D	Bhu	S	Hemavathy	58

23	Gowrimanohari	A	|	Ma	|	I	Dharmavathy	59
24	Varunapriya		|	Sha	|		Neetimathi	60
25	Maararanjani		|	Pa	|	R	Kaantaamani	61
26	Chaarukesi	B	|	Sri	|	U	Rishabhapriya	62
27	Sarasaangi	A	|	Go	|	D	Lataangi	63
28	Harikaambhoji	N	|	Bhu	|	R	Vaachaspathy	64
29	Dheerasankaraabharanam	A	|	Ma	|	A	Mechakalyaani	65
30	Naagaanandini		|	Sha	|		Chitraambari	66
31	Yaagapriya	R	|	Pa	|	A	Sucharithram	67
32	Raagavardhani	U	|	Sri	|	D	Jyotiswaroopini	68
33	Gaangeyabhooshani	T	|	Go	|	I	Dhaatuvarthini	69
34	Vaagatheeswari	H	|	Bhu	|	T	Naasikaabhooshani	70
35	Shoolini	U	|	Ma	|	Y	Kosalam	71
36	Chalanaata		|	Sha	|	A	Rasigapriya	72

Many of the melakartas have alternate names like in the example just cited and some of these are listed in the Appendix. In addition, some of the common ones (like Thodi) are listed with prefixes (Hanumathodi). This is in accordance with the so called 'Katapayaathi' formula. Using this formula, numerical values are assigned to consonants as listed in the following table (the devanagari script is the basis upon which this assignment is done). To find out what is the location of a melakarta in the table, the first two consonants are deciphered using the numerical assignment table and the resulting number is inverted left to right. For example, consider Hanumathodi - the first two consonants being Ha and Na. Ha is assigned 8 and Na is zero. The resulting number if 80 and after inversion, this yields the number 8, which is the melakarta number corresponding to Hanumathodi. One must be careful in decoding prefixes - for example, Thodi, Sankaraabharanam and Kalyaani are melakartas which take on prefixes to identify their melakarta numbers but Naata, Bhairavi and Kaambhoji are not melakartas but actually janya ragas of Chalanaata, Natabhairavi and Harikaambhoji respectively. The naming of melakartas in accordance with the Katapayaathi formula is generally attributed to Govindacharya. Govindacharya was well versed in astrology and the Katapayaathi convention has been widely used in astrology for centuries.

Once the melakarta number is known, one can use the chakra scheme to identify the swaras in it. As an example, consider Shanmugapriya. The consonants are Sha and Ma. Sha=6 and Ma=5 to yield the melakarta number 56. Dividing 56 by 6 yields a quotient of 9 and a remainder of 2. This means that Shanmugapriya belongs to the 10th (or Disi) chakra and is the second (or Sri) raga in that chakra. Thus Shanmugapriya is identified as Disi-Sri. Then, the swaras in Shanmugapriya are (collecting the purvangam and uttarangam from the tables) Sa - Chatusruthi Rishabam - Sadharana Gandharam - Prati Madhyamam - Pa - Suddha Dhaivatham - Kaisika Nishadam - Sa. Note that in figuring out the chakra, we need to add one to the quotient to obtain the chakra number. We can use the melakarta table to directly find that Shanmugapriya is Disi-Sri and end up with the same swaras. The following keyboard diagram illustrates the location of the swaras in Shanmugapriya for one kattai sruthi.

Swaras in Raga Shanmugapriya
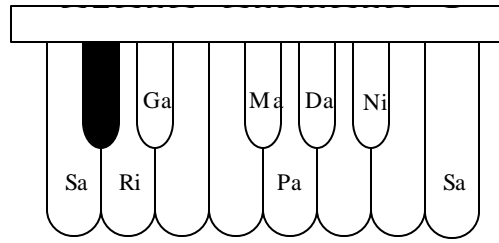
Letter Values in Katapayaathi Formula

Values	Letters			
	Ka series	Ta	Pa	Ya
1	Ka	Ta (as in Tom)	Pa	Ya
2	Kha	Tha	Pha	Ra
3	Ga	Da (as in dumb)	Ba	La
4	Gha	Dha	Bha	Va
5	Nga (as in Bengal)	Na (as in Anna)	Ma	Sa (as in Siva)
6	Cha (as in chip)	Ta (as in with)		Sha(as in Shut)
7	Chha	Tha		Sa (as in Sea)
8	Ja	Da		Ha
9	Jha	Dha		
0	Ngya	Na (as in Pen)		

It is worthwhile to observe here that the Pa, Sri, Go, Bhu, Ma, Sha designation is also based on the Katapayaathi formula (with Sri treated as ra). The formal organization of the melakartas provides some insights into the similarities between certain ragas. Ragas in the same chakra share their purvangam and thus, sound similar in that portion. This explains, for example, the similarity between Kharaharapriya and Kiravaani. Ragas whose melakarta numbers differ by a multiple of six (meaning they have the same Pa-..-Sha designation) have the same uttarangam and this too causes similarity, as in the case of Lataangi and Kaamavardhani. One can find many pairs of melakarta ragas that differ by a single swaram, as in the case of Lataangi and Kaamavardhani (which differ only in Ri). Locating such pairs is often very instructive. A good musician makes it a point not to dwell on chains of swaras that are shared by various ragas, but often introduces contrasting swaras that are designed to let the listener identify the similarities and the differences simultaneously. This aspect can be used as a test of how good a musician really is. In a recent concert, a popular musician was performing a composition in the raga Chaarukesi. Chaarukesi can be seen to have the same purvangam as Sankaraabharanam and the same uttarangam as Shanmugapriya or Thodi. However, singing the purvangam portion of Sankaraabharanam and then the uttarangam of Shanmugapriya or Thodi has very little to do with the true swaroopam of Chaarukesi. This is like arguing that glueing a lion's head to a human torso results in the creation of a new being, when all it really does is create neither a lion nor a human being. The resulting creature is a poor excuse for a human or a lion and can be seen only as such. The use of gamakkas is also intricately connected to the concept of raga swaroopam and even though swaras may be the same, the gamakkas are often different, leading to ragas that are quite distinct in character.

The melakarta ragas in which vivadi swaras appear are called as vivadi melakartas. Thus all melakartas of Indu, Ruthu, Rishi and Aditya chakras as well as all melakartas with Pa or Sha designation are vivadi melakartas. The Pa and Sha designated ragas have a vivadi swara in their uttarangam while the Indu, Ruthu, Rishi and Aditya chakra

ragas have a vivadi swara in their purvangams. Thus, there are 40 vivadi melakartas, out of which 8 have two vivadi swaras and the rest one vivadi swara each. If a melakarta system is constructed without the vivadi melakartas, a number of fairly common ragas will have to be treated as being outside the system (eg. Gaanamurthy, Jhaalavaraali). Further, janya ragas like Naata will have no associated melakarta, exposing the limitations of the classification system.

Janya Ragas

Janya ragas, as we have seen before, are derived from the melakarta ragas. The simplest way to generate a janya raga is to leave out one or more of the swaras in the arohanam and/or avarohanam. For example, if we drop out the Ma and Ni in the arohanam of Dheerasankaraabharanam, we end up with Sa - Ri - Ga - Pa - Da - Sa for the arohanam and a sampoorna avarohanam. The resulting raga is called Bilahari. Thus, Bilahari is described as a janya raga of the 29th melakarta Dheerasankaraabharanam with an arohanam - avarohanam of Sa - Ri - Ga - Pa - Da - Sa, Sa - Ni - Da - Pa - Ma - Ga - Ri - Sa. This means that when going up the scale, one may use only the notes of the arohanam, namely, Sa, Ri, Ga, Pa, Da and Sa whereas, all seven notes can be used in descent. Thus, when a Ma or Ni is used, one has to necessarily descend (using notes from the avarohanam).

Dropping out more than two swaras results in a scale that is very limited and experience suggests that it is virtually impossible to create a distinct raga swaroopam with the remaining swaras. However, there are some ragas which use only four swaras in the arohanam or avarohanam as in the case of Navarasa Kannada, derived from the 28th melakarta Harikaambhoji, with a structure of Sa-Ga-Ma-Pa-Sa, Sa-Ni-Da-Ma-Ga-Ri-Sa. Just like a complete arohanam or avarohanam is called sampoornam, one with a single swara dropped out is called shadava and one with two swaras left out is termed oudava. Allowing the arohanam and avarohanam to be sampoornam, shadava or oudava independently, the following possible arohanam - avarohanam types can be constructed.

(1)   sampoorna - sampoorna
(2)   sampoorna - shadava
(3)   sampoorna - oudava
(4)   shadava - sampoorna
(5)   oudava - sampoorna
(6)   shadava - shadava
(7)   shadava - oudava
(8)   oudava - shadava
(9)   oudava - oudava

The first case evidently refers to the melakartas themselves and does not generate any janya ragas. The example of Bilahari belongs to the 5th or oudava - sampoorna case. Using the sampoorna - shadava case as an example, there are 72 sampoorna arohanams and six shadava avarohanams for each, leading to total of 432 janya ragas of this type. By the same argument, there are 432 janya ragas of shadava - sampoorna type. Following this procedure, one can arrive at a total of about thirty thousand independent janya ragas. However, a large number of these are not in use since they do not have distinct raga swaroopas. This brings us to the important observation that it is not just mathematical jugglery that produces ragas. As the saying goes, 'Ranjayathi ithi Raga' - that which is beautiful is a raga. Ragas are produced through experimenting with the possible combinations, looking for distinct swaroopas. This process has been conducted for centuries by composers and musicians to arrive at the few hundred or so janya ragas currently in use.

The type of janya raga we have considered so far, namely, what is derived by simply dropping notes from a melakarta raga, is called as an Upaanga raga. There are alternate means of generating janya ragas. The arohanam and/or avarohanam can use a twisted progression. For example, we can construct a janya raga from Dheerasankaraabharanam using the arohanam Sa - Ri - Ma - Da - Ni - Ga - Pa - Sa and a simple sampoorna avarohanam. The resulting raga is called Katanakuthoohalam. A janya ragam employing a twisted arohanam and/or avarohanam is termed as a Vakra ragam. We can also mix notes from two melakartas in the arohanam and avarohanam to produce janya ragas. For example, the ragam Bhairavi uses Chatusruthi Dhaivatham in its arohanam and Suddha Dhaivatham in its avarohanam. This type of structure is indicated by the term Baashaanga ragam. A ragam can be

Baashaangam or Upaangam but not both. The Vakra characteristic can be combined freely with both types. The result is that a very large number of combinations are possible and only the ability to create a distinct swaroopam dictates what combinations are actually used in creating janya ragas. The description of a janya raga usually indicates the melakarta from which it is derived, whether it Vakram or not, whether is Upaangam or Baashaangam, and if it Baashaangam, the swaras which make it so. The arohanam and avarohanam provide further details (like sampoorna, shadava or oudava).

The term varja is sometimes used to indicate missing swaras. For example, the raga Sriranjani has an arohanam - avarohanam of Sa - Ri - Ga - Ma - Da - Ni - Sa, Sa - Ni - Da - Ma - Ga - Ri - Sa and is derived from the 22nd melakarta Kharaharapriya. It is thus described as a Panchama varja raga, derived from Kharaharapriya. Consider another example, Malayamaarutham. It is a Madhyama varja raga derived from the 16th melakarta Chakravaaham. The designation of the parent ragam as Chakravaaham is subjective since the Madhyama varja raga derived from the 52nd melakarta Raamapriya is identical to Malayamaarutham. The problem is that Chakravaaham and Raamapriya differ only in Ma and since Malayamaarutham is Madhyama varja, it can be derived from either. In such cases, the gamakas used in the janya raga have to be studied to decide which of the melakartas is appropriately described as the parent raga. This problem is compounded in the case of Baashaanga ragas which are anyway derived from multiple melakartas. In any case, the assignment of a parent melakarta is somewhat subjective and various experts often ascribe different parents for a given janya raga. A well known example is the ragam Mohanam, which has an arohanam - avarohanam of Sa - Ri - Ga - Pa - Da - Sa, Sa - Da - Pa - Ga - Ri - Sa, using Chatusruthi Rishabam, Anthara Gandharam and Chatusruthi Dhaivatham. Various authors have classified it as a janya ragam of Harikaambhoji (melakarta no. 28) and Mechakalyaani (65) and more are possible. It is a matter of individual viewpoint as to which is the parent ragam. As long the distinct swaroopam is maintained, it really does not matter what is assigned as the parent ragam.

<center>**Taalam**</center>

We have seen that the term raga refers to the tune or melody characteristics. The analogous term referring to the rhythm or beats of Carnatic music is taalam. It indicates the pacing of the music and the placement of syllables in the composition. It is vital to realize that the taalam system is essentially based on a cyclic pattern; in other words, the rhythm is always cyclic. In Carnatic music, the singer indicates the taalam using gestures. There are three basic hand movements used in keeping the rhythm - the downward beat with the palm facing down, called thattu, the wave (sometimes the downward beat with the palm facing up) called veechu and counts using one finger for each count staring with the little finger (sometimes using the thumb to indicate a finger or portions of a finger). These basic movements are combined into three groups, called Laghu, Dhrutham and Anudhrutham. A Laghu is one thattu followed by a specified number of counts to make up the requisite number of beats. A Dhrutham is one thattu followed by one veechu while an Anudhrutham is just one thattu. Each beat or unit of taalam is termed as an aksharam and thus, an Anudhrutham is one aksharam long, a Dhrutham is two aksharams long and the Laghu is of variable length. There are several other movements but these are rarely seen in practice.

The absolute duration of an aksharam is not fixed and it varies, depending on the composition and the mood of the performer. This is similar to the way in which the absolute pitch of the swaras is not fixed but defined only relative to the reference pitch or sruthi. The aksharam is further divided into a number of swaras and this division is referred to as gathi or nadai. Four swaras per aksharam is standard and is termed Chaturasra nadai. The other standard divisions and the associated number of swaras per aksharam are Tisra (three), Khanda (five), Misra (seven) and Sankirna (nine). These divisions apply to medium tempo or Madhyama Kaalam. The divisions can be doubled to yield a fast tempo termed Dhuritha Kaalam or halved to yield the slow Chowka Kaalam. Further doubling and halving are also possible but rarely heard. Most of Dikshithar's compositions have the last line of Anupallavi and Charanam (see Elements of Recital section for definitions) set to Dhuritha Kaalam.

There are seven common taalams employing a mixture of the movements just described. In standard notation, the Laghu is indicated by a |, the Dhrutham by a 0 and the anudhrutham by a U. The length of the Laghu is indicated by a subscript placed after the |. For example, $|_4$ indicates a Laghu of length 4, which comprises of a thattu followed by a three count on the fingers for a total of four aksharams. The seven common taalams and their components are as follows:

Eka	|
Roopaka	0|
Triputa	|0 0
Mattya	|0|
Jhampa	|U 0
Dhruva	|0||
Ata	||0 0

The length of the Laghu has not been specified in the classification. There are five possible Laghu lengths called Tisra (length 3 aksharams), Chaturasra (4 aksharams), Khanda (5), Misra (7) and Sankirna (9). Each of these five Laghus can occur in the seven basic taalams to produce a total of thirty five taalams. For example, Misra Jhampa taalam ($|_7$ U 0) has a Laghu of 7 aksharams, an Anudhrutham and a Dhrutham. This would be indicated by a thattu

<center>18</center>

(counted one) followed by a six count on the fingers (counts two through seven), two thattus and a veechu, for a total of ten aksharams. Each of these thirty five taalams can be divided into the five nadais to yield 175 beat patterns. Sometimes, the taalam names are used without indicating the length of the Laghu and are to be interpreted as follows: Eka (Chaturasra Eka), Roopaka (Chaturasra Roopaka), Triputa (Tisra Triputa), Jhampa (Misra Jhampa), Ata (Khanda Ata). Chaturasra Roopakam is usually indicated by two thattus and a veechu (each of two akshara length) in order to economize hand motion.

In addition to the taalams just described, there are three more common taalams - Aadi, Khanda Chaapu and Misra Chaapu. Aadi taalam is just the name given to the most common taalam - Chaturasra Triputa or $|_4$ 0 0. Khanda Chaapu is a five beat taalam also called arai Jhampa (or half Jhampa) and is usually indicated 0 U 0, though there is really no fixed way of indicating it. One can also see a thattu of two aksharams followed by two veechus of one and two aksharam durations. Khanda Chaapu is often used as a version of Misra Jhampa. Misra Chaapu is similar to Tisra Triputa and is sometimes used as an alternative. The usual indication consists of a thattu of three aksharams followed by two veechus or two thattus of two aksharams each, for a total of seven aksharams (and hence the name).

There is another aspect of taalam which merits attention - the starting point of the song in relation to the taalam or the eduppu as it is called. Many songs start simultaneously with the beat and this is termed as sama eduppu indicating that the start is level with the taalam. Often, the song starts after the taalam is started, leaving an empty rhythm pattern at the beginning. This gap allows the singer greater freedom in improvisation (see also under the section titled Elements of a Recital). This is indicated by the term anaagatha eduppu. Sometimes, the song starts before the beat and this is termed atheetha eduppu. This construction is often used to add a one or two syllable prefix (eg. Hari, Sri, Amba) to the text of the melodic line. A peculiar eduppu is associated with a taalam called Desadi taalam. Though this taalam actually consists of four movements, each of two aksharam duration, it is customary to keep pace for this taalam using simple Aadi taalam. Then, the eduppu is at one and half aksharams from the start of the taalam or three eighths way into the laghu. An example for Desadi eduppu is the song 'Bantu reethi kolu viya vayya Raama' in the ragam Hamsanaadham.

Elements of a Recital

The exact form of a concert or recital changes with time, adapting to the perceived needs of the listener and the performer. Much of the form as described here is generally attributed to the tradition established by Sri Ariyakkudi Ramanuja Iyengar. There are two essential portions in any Carnatic Music Recital - a composed portion and an extempore portion. The composed portion is fixed (more or less) while the extempore or improvisational portion is heavily dependent on the skills and imagination of the performer. This extempore portion is thus governed by the mind and is hence referred to as manodharma sangeetham. Recitals often start with a Varnam. A Varnam is a composed piece of fairly short duration usually set to Aadi or Ata taalam. It is usually performed at the start of a recital as a warm up piece. The lyrics are simple and consist mostly of long syllables and swara phrases of various lengths which bring out the essential features of the raga. There is usually a Pallavi and an Anupallavi, followed by a Mukthaayiswaram and repetitions of a Charanam with various Chittaswarams. The Pallavi establishes a characteristic theme of the raga, typically in the lower portion or purvangam of the raga, while the Anupallavi provides a parallel or contrasting theme in the upper portions (uttarangam). The Mukthaayiswaram and Chittaswarams both consist of chains of swaras rendered using the swara syllables themselves (Sa, Ri, etc.). The Charanam is often composed on a raga theme related to the Pallavi and the Anupallavi.

The recital then proceeds with the rendition of a number of Krithis or Kirthanais (songs) in various ragas and taalams. These songs, which are the main items of performance, are composed pieces of various lengths. Most compositions are of a devotional nature due to the historically close relationship between music and religion. Generally, a few compositions of The Trinity are included. The Trinity refers to the three great composers of Carnatic Music, Thyagaraja, Muthuswami Dikshithar and Shyama Shastry. The three were contemporaries who lived in the late 18th and early 19th centuries in and around Tiruvarur (near the South Indian City of Tanjore). Thyagaraja is well known for his five compositions in the ragas Naata, Gowla, Aarabhi, Varaali and Sriragam, generally referred to as the Pancharatnams. Dikshithar's most famous compositions include the Kamalaamba Navaavarna Krithis and the Navagraha Krithis. Thyagaraja and Shyama Shastry composed mainly in Telugu whereas Dikshithar mostly used Sanskrit. Dikshitar and Shyama Shastry have often included the name of the raga also in their lyrics. The word Thyagaraja appears in Thyagaraja's compositions to identify the composer. Dikshithar used Guruguha as his identifier while Shyama Shastry used Shyama Krishna. The identifiers for several other composers are listed in the appendix.

Krithis formally have a Pallavi, an Anupallavi and one or more Charanams. A Kirthanai is similar to a Krithi but has no Anupallavi. Often, a number of Sangadhis are used for each line of the song. Sangadhi is the repetition of a single line or similar short portion of the song using various melodic tunes. Initially, the tune is simple and slowly, the structure of the raga is revealed using more complicated structures. This portion is generally composed but many performers include their own variations also. A Swarajathi is sometimes included along with the Krithis and Kirtanais in the main portion of the concert. A Swarajathi is like a Krithi but its Charanam section is rendered first using the swaras and then the lyrics. One of the most dedicated Carnatic musicians of our times, Sri Semmangudi Srinivasa Iyer, often used to sing Shyama Shastry's Swarajathi composition in the raga Bhairavi beginning with the words (Kanji) Kamakshi. The Charanam sections of the Pancha Ratna Keertanais of Thyagaraja are customarily sung in the Swarajathi fashion i.e., first using the swarams and then with the lyrics.

Some of the songs are preceded by an Aalaapanai, and may include Niraval and/or Kalpanaaswaram. An Aalapanai is an improvisation in the same raga as the song. It has no lyrics and only abstract (meaningless) syllables are used (eg. Ta, Da, Ri, Na, Nau). There is no rhythm for this portion of the performance which is essentially an

extempore attempt by the performer to convey the raga swaroopam as experienced by him/her. The Aalaapanai has a formal structure, similar to the Pallavi - Anupallavi scheme. It includes movements in all the three sthaayis as the raga allows. Sthaayi is the octave or register of the swaras. The normal or middle sthaayi is termed Madhya sthaayi, the upper octave is Thaara sthaayi, the lower octave is Mandhara sthaayi. Similar names exist for further octaves. An Aalaapanai generally starts in the Madhya sthaayi, proceeds upward into the Thaara sthaayi and then downward to the Mandhara sthaayi before returning to end in the Madhya sthaayi. This structure is modified for ragas which are better exposed otherwise. For example, Aalaapanais in the raga Ataana are often started in Thaara sthaayi. Depending on the raga and the imagination and skills of the performer, an Aalaapanai can take up from a few minutes to a half hour or more. In folklore, there are stories of great performers who have rendered Aalaapanai for a week, without any significant repetition of the raga phrases used.

Niraval is similar to sangathi but performed in an extempore manner. The performer selects a single line or a similar short portion of the song and renders it in various tunes, all within the limits of the ragam and the taalam. Kalpanaaswaram is to Chittaswaram what Niraval is to Sangathi. The performer renders improvised swara phrases (in the same raga as the associated song) while repeating a selected line from the song after each chain of phrases, all the time staying within the constraints of the taalam. The empty space in the taalam for songs which have an Anaagatha eduppu allows the performer to return to a fixed short phrase at the end of each chain of Kalpanaaswarams with great momemtum, adding to the graceful structure of the performance.   Successful Kalpanaaswaram rendition requires thorough study of the elements of the ragam. Madurai Mani Iyer was well known for his eagerness to sing Kalpanaaswarams with every song.

Many recitals have a major item called Ragam - Thaanam - Pallavi. The Ragam portion is an elaborate Aalaapanai, a study in the structure of the chosen ragam. The Thaanam portion is like an Aalaapanai but it has rhythm. The rhythm is maintained not by an explicit taalam, but by confining the voicing to syllables of more or less fixed length. Typical syllables used in a Thaanam include Ta, Na and Nom. Thaanam is an essential part of veena playing due to the nature of the instrument. The Pallavi portion is often set to rare taalams and generally consists of rendering a lyrical line at various speeds so as to fit the taalam. For example, the line can be rendered once for each cycle of the taalam, twice per cycle, once every two cycles etc. This can be accomplished by keeping the rhythm at a fixed speed and varying the pace of the melody or by varying the rhythmic pace while the lyrical line is rendered at a constant speed. Pallavi rendition is intimately connected with the performer's sense of rhythm. When mentioning Pallavi singing one can hardly forget Shatkaala Govindar, a contemporary of The Trinity, whose title of Shatkaala was given due to his exceptional ability to sing at six speeds. It is also common to make the Pallavi portion into a Raga-malika (garland of ragas), meaning, a number of lines, each in a different raga. The Pallavi portion generally includes Kalpanaswarams also.

Devotional items are quite common towards the end of the recital. These include slokas, Bhajans and compositions by or in honor of the performer's Guru(s). A Thillaana is performed at or very near the end of the concert. The Thillaana is a composed piece intended mainly for dance. Usually, there are no lyrics and only certain syllables denoting division of the taalam are used (Ta, Deem, Thom, Takadimi etc.). The concluding piece of the recital is called Mangalam and is generally in the ragas Saurashtram, Madhyamavathy or Surati.

Grahabedam and Symmetries

The topics of this section are of fairly advanced nature and somewhat abstract and mathematical. Readers who are not mathematically oriented may skip this section. The basic principles behind Grahabedam and symmetry are rooted in mathematics. Thus, a certain amount of mathematical notation is almost unavoidable in any explanation of these concepts. Grahabedam is the process of modifying ragas by shifting the base note Sa or the sruthi to various swara sthanas. Symmetry indicates certain types of similarities in the structure of the swaras used in a ragam. Grahabedam is defined for melakartas as well as janya ragas. Consider Dheerasankaraabharanam (Bana - Ma), the 29th melakarta ragam. The swara sthanas for it in one kattai sruthi are as shown in the following keyboard diagram.

Swaras in Dheerasankaraabharanam
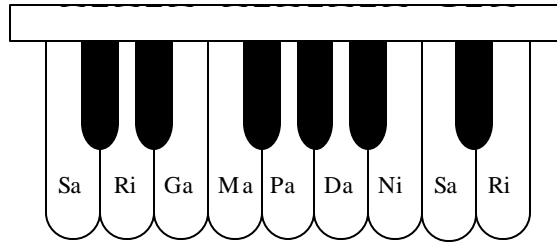
Suppose we continue to use the same swara sthanas but shift the sruthi to two kattais, what was Sankaraabharanam takes on a different appearance. The swara locations for two kattai sruthi are given in the following figure.

Swaras for two kattai sruthi
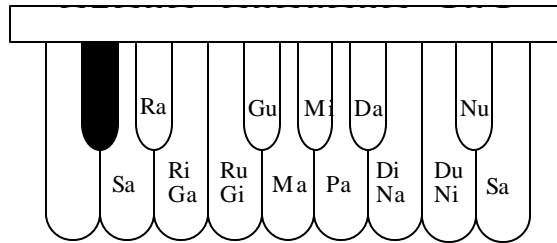
Using this figure, we see that what used to be Chatusruthi Rishabam now becomes Sa and Anthara Gandharam becomes Chatusruthi Rishabam. Continuing along, the Suddha Madhyamam becomes Sadharana Gandharam, Pa becomes Suddha Madhyamam, Chatusruthi Dhaivatham becomes Pa, Kakali Nishadam becomes Chatusruthi Dhaivatham, Sa becomes Kaisika Nishadam. Consulting the melakarta tables, we see that the new swaras correspond to the 22nd melakarta Kharaharapriya (Veda - Bhu). Thus, moving the sruthi to the swara Ri of Sankaraabharanam results in Kharaharapriya. It should be remembered that the absolute pitch of the swaras continue to be the same; it is only because of the shifting of the origin of the scale (the Sa) that a different raga is produced. Evidently, one can carry out the process for janya ragas also.

Consider a notation system for the swara and swara sthanas as follows. Let us represent the swara sthanas by a string of 12 digits, each one corresponding to the twelve swara sthanas into which an octave is divided. The presence of a swara sthana is denoted by a one in the corresponding digit and the absence by a zero. Thus, in the above example of Sankaraabharanam, the representation would be [101011010101]. The first 1 corresponds to Sa; the next swara sthana corresponds to Suddha Rishabam which does not occur in Sankaraabharanam and thus the corresponding digit is 0. The third digit is for Chatusruthi Rishabam and Suddha Gandharam. Since Chatusruthi

Rishabam occurs in our example, the third digit is set to 1. The same process can be continued to obtain all the twelve digits. Note that the first digit is always 1 to indicate the use of Sa. In the case of melakartas, Pa is always used and thus, the eighth digit is always 1. Further, all melakartas use seven and only seven swaras and thus the notation always contains seven ones and five zeros. In general, the number of ones in the notation denotes the number of swaras used in that raga. The following list gives the number strings corresponding to the twelve chakrams and the Pa-Sri.. designations. Note that the Purvangam is represented by seven digits and the uttarangam by five digits. The purvangam notations carry a 1 in parenthesis to indicate that the next swara is Sa, which is always present.

Indu	1110010	Rishi	1110001	Pa	11100(1)
Netra	1101010	Vasu	110100	Sri	11010(1)
Agni	1100110	Brahma	1100101	Go	11001(1)
Veda	1011010	Disi	1011001	Bhu	10110(1)
Bana	1010110	Rudra	1010101	Ma	10101(1)
Ruthu	1001110	Aditya	1001101	Sha	10011(1)

Using this notation, Grahabeda is very easy to handle. One simply moves digits from one end of the number to the other. In the example just considered, Sankaraabharanam is represented by [101011010101]. To move the sruthi to Ri, we make the digit corresponding to Ri as the first digit to get [1011010101]. The two digits which were removed are moved over to the right end to obtain [101101010110]. This can be easily verified to represent Kharaharapriya. This ability of a raga to generate other ragas through Grahabedam is denoted by the term Murchanaakara. The absence of this characteristic is termed Amurchanaakara. In light of the above example, Dheeraankaraabharanam and Kharaharapriya are Murchanaakara ragas. Sometimes, the process of grahabedam on a ragam leads to non-existent scales. For example, if we take the Ni of Sankarabharanam as the base swara, we get [110101101010]. This scale has two Madhyamas and no Panchamam and such a scale is not allowable under the current melakarta scheme. Evidently, for a raga to be Amurchanaakara, all the grahabeda derived scales of it should be somewhat like this. Jhaalavaraali (39) is an example of a melakarta which is an Amurchanaakara ragam.

It is important to note that Grahabedam is necessarily a two way process. Instead of generating Kharaharapriya from Sankaraabharanam, we can start with Kharaharapriya and move the sruthi to the Ni to get Sankaraabharanam. Hence, it is appropriate to group together ragas which can be derived from each other and state, for example, that Kharaharapriya and Sankaraabharanam are Grahabeda pairs instead of inappropriately stating that Kharaharapriya can be derived from Sankaraabharanam through Grahabedam. The example just considered leads to the most famous Grahabedam group of melakartas consisting of Mechakalyaani (65), Dheerasankaraabharanam (29), Harikaambhoji (28), Kharaharapriya (22), Natabhairavi (20) and Hanumathodi (8). This group possesses another interesting property. Mechakalyaani uses the 'big' variety of all the swaras (big Ri, big Ga etc.) and proceeding down the group as it is written above, the 'big' swaras are progressively replaced by corresponding 'small' swaras. Thus Dheerasankaraabharanam uses 'small' Ma (and the rest, 'big'), Harikaambhoji uses 'small' Ma and Ni and so on until we reach Hanumathodi, which uses the 'small' variety of all the swaras.

The Grahabedam process as above can be used on janya ragas also. The notation can handle only janya ragas with symmetric arohanam and avarohanam (meaning the arohanam and avarohanam should have the same swaras) and janya ragas with vivadi swaras cannot be distinguished correctly. The most famous Grahabedam group

of janya ragas includes Mohanam, Hindolam, Suddha Dhanyaasi, Suddha Saaveri and Madhyamaavathy. Some other groups are listed in the Appendix.

The next logical question that arises is whether it is possible for a raga (assumed to have symmetric arohanam and avarohanam) to be Grahabedam derivable from itself. If the raga has five or seven swaras (including the fixed Sa), then it turns out that it cannot be Grahabedam derived from itself. Thus, melakartas are not self Grahabedam derivable since they all have seven swaras. If a ragam is self Grahabedam derivable, it can be confusing to the listener since the same tune can belong to a single ragam at two different sruthis! Perhaps, it is no coincidence that we see ancient systems of music with five note scales and the current system with seven note scales, but no significant six note scales. The seven swara scale is most probably here to stay since setting more than seven swaras into twelve swara sthanas would allow very little room for the creation of distinct base ragas especially if the Panchama sthana is reserved and always present.

Consider the 1st melakarta, Kanakaangi (Indu - Pa). It is represented by [111001011100(1)]. Note the symmetry between the lower and upper portions of the structure due to the repeating sequence 111001. This is an example of a class of symmetry, where the lower and upper portions (not exactly the purvangam and uttarangam, but close) of a raga have a similar structure. This characteristic is possessed by the following melakartas: Hanumathodi (Netra - Sri), Maayaamaalavagowla (Agni - Go), Kharaharapriya (Veda - Bhu), Dheerasankaraabharanam (Bana - Ma) and Chalanaata (Ruthu - Sha). The sixth melakarta Thaanaroopi (Indu - Sha) is denoted by the string [111001010011(1)]. The lower portion of this 111001 is the same as the upper portion 100111 written backwards. This means that the swara steps in the lower portion of the raga in the arohanam are similar to the swara steps in the upper portion in the avarohanam, or these ragas employ a similar swara step structure in the arohanam and avarohanam. This is another type of symmetry and the melakartas which possess this property are Thaanaroopi (Indu - Sha), Kokilapriya (Netra - Ma), Maayaamaalavagowla (Agni - Go), Kharaharapriya (Veda - Bhu), Chaarukesi (Bana - Sri) and Yaagapriya (Ruthu - Pa).

Note that Maayaamaalavagowla possesses both types of symmetries we have looked at. Further, it has no isolated swaras (denoted by the ones all appearing in pairs). This characteristic makes a raga easier to sing (or play on an instrument) since pairs of swaras occur together. It is probably for this reason that this ragam is almost invariably the first that a student is taught. In fact many of the initial lessons are set to this ragam[+]. When an advanced stage is reached and students begin to render Kalpanaaswaras, many find it convenient to sing first in Maayaamaalavagowla or its Prati Madhyama pair Kaamavardhani. A systematic examination of the compositions of Muthuswamy Dikshithar reveals a good degree of specialization in Maayaamaalavagowla and its janya ragas[*]. Saint Thyagaraja's compositions exhibit a similar lean towards Kharaharapriya and its janya ragas. Perhaps, these facts are related to the high degree of symmetry possessed by these two ragas.

[+]This practice is generally attributed to Purandara Dasa, who is often called the father of modern Carnatic music.

[*]In fact, there is an interesting story in folklore about how Dikshithar started composing songs. From a very young age, Dikshithar was a religious person and used to travel to many temples. On one such tour, he was at the temple of Lord Subramanya in Thirutthani when an old man suddenly came up to him, dropped a piece of sugar in his mouth and after blessing him, disappeared mysteriously. Dikshithar was inspired by this incident and almost immediately composed the (some say his first) song 'Sri Naathaathi Guruguho' in Maayaamaalavagowla.

Synonymous Ragas

As we have seen before, different names have been assigned to the same ragam by various sources, leading to some confusion on the part of listeners and performers alike. This problem is very evident when one compares the compositions of Thyagaraja and Muthuswamy Dikshithar, since the former used the Kanakaangi-Rathnaangi scheme of Govindacharya while the latter followed the Knakaambari-Phenadhyuthi scheme (which did not require sampoorna melakartas). In the case of Janya ragas also, there are some discrepancies in the names as well as definitions used in the two systems. The following list contains the names of the melakartas in the Kanakaambari - Phenadhyuthi scheme. Some of the names are marked with an asterisk (*) to indicate that they refer to the same raga as in the Kanakaangi - Rathnaangi scheme. Thus, Chaamaram, which is marked, is the same as the corresponding (56th) melakarta, namely, Shanmugapriya. Detecting such correspondence is tricky since different sources often offer conflicting definitions for the same ragam. The indicated correspondences were obtained after a careful scrutiny of the songs as given in Rangaramanujam Iyengar's Krithi Mani Malai.

1	Kanakaambari	37	Sougandhini
2	Phenadhyuthi	38	Jaganmohanam
3	Gaanasaamavaraali	39	Dhaalivaraali*
4	Bhaanumathi	40	Nabhomani
5	Manoranjani*	41	Kumbhini*
6	Thanukirthi	42	Ravikriya*
7	Senaakrani	43	Girvaani
8	Janathodi*	44	Bhavaani*
9	Dhunibinnashadjam*	45	Sivapantuvaraali*
10	Nataabharanam*	46	Sthavaraajam*
11	Kokilaaravam*	47	Sowveeram*
12	Roopavathy*	48	Jeevanthini*
13	Geyahejjajji *	49	Dhavalaangam*
14	Vaativasanthabhairavi	50	Naamadesi*
15	Maayaamaalavagowla*	51	Kaasiraamakriya*
16	Toyaveghavaahini	52	Ramaamanohari*
17	Chaayaavathi	53	Gamakakriya
18	Jeyasuddhamaalavi	54	Vamsavathi*
19	Jhankaarabhramari	55	Shyaamala
20	Naarireethigowla	56	Chaamaram*
21	Keeranaavali	57	Soomadhyuthi*
22	Sriraagam	58	Desisimhaaravam*
23	Gowrivelaavali*	59	Dhaamavathy*
24	Veeravasantham	60	Nishadham*
25	Sharaavathy	61	Kuntalam*
26	Tarangini	62	Ratipriya*
27	Sowrasena*	63	Geetapriya*
28	Harikedaaragowla	64	Bhooshaavathi*
29	Dheerasankaraabharanam* 65		Saantakalyaani*
30	Naagaabharanam*	66	Chathurangini*
31	Kalaavathy	67	Santhaanamanjari*
32	Raagachudaamani*	68	Jyothiraagam*
33	Gangaatarangini	69	Dhowthapanchamam*
34	Bhogachaayaanaata*	70	Nasaamani*
35	Sailadesaakshi*	71	Kusumaakaram*
36	Chalanaata*	72	Rasamanjari*

The following list indicates janya ragas which are known by different names.

Suddha Dhanyaasi or Udaya Ravichandrikaa

Suddha Saaveri or Devakriya

Aabheri or Karnaataka Devagaandhaari

Grahabeda Groups

The following list contains groups of melakartas that are Grahabeda derivable from each other within any group. These are thus Murchanakara melakarta ragas.

Kanakaangi, Kaamavardhani

Rathnaangi, Gamanasrama, Jhankaaradhwani

Gaanamurthy, Visvambari, Shyaamalaangi

Vanaspathy, Maararanjani

Maanavathy, Kaantaamani

Senaavathy, Lataangi, Sooryakaantham

Hanumathodi, Mechakalyaani, Harikaambhoji, Natabhairavi, Dheerasankaraabharanam, Kharaharapriya

Dhenuka, Chitraambari, Shanmugapriya, Shoolini

Naatakapriya, Vaachaspathy, Chaarukesi, Gowrimanohari

Kokilapriya, Rishabhapriya

Gaayagapriya, Dhaatuvardhani

Vakulaabharanam, Kosalam, Kiravaani, Hemavathy

Maayaamaalavagowla, Rasigapriya, Simhendhramadhyamam

Chakravaaham, Sarasaangi, Dharmavathy

Haatakaambari, Gavaambhodhi

Varunapriya, Raagavardhani

Naagaanandini, Bhavapriya, Vaagadheeswari

Gaangeyabhooshani, Neetimathy

Chalanaata, Subhapantuvaraali

Shadvidhamaargini, Naasikaabhooshani

The following are the Amurchanaakara melakartas, meaning they are not related to any other melakarta through Grahabedam.

Taanaroopi

Roopavathy

Yaagapriya

Saalagam

Jalaarnavam

Jhaalavaraali

Navaneetham

Paavani

Raghupriya

Suvarnaangi

Divyamani

Dhavalaambari

Naamanaaraayani

Raamapriya

Sucharithra

Jyotiswaroopini

The following are Grahabeda related Janya raga groups and hence it is appropriate to call these Janya ragas as Murchanakara Janya ragas.

Suddha Saaveri, Suddha Dhanyaasi, Madhyamaavathy, Hindolam and Mohanam

Ghambeera Naata and Bhoopaalam

Kalkata and Lalitha

Naagaswaraavali and Hamsadwani

Aarabi, Mohana Kalyaani, Aabheri and Kedaara Gowla

Dhanyaasi and Saalaka Bhairavi

Aabhogi and Valagi

Kaambhoji and Desiya Thodi

Bilahari and Yadukula Kaambhoji

In the preceding list, the first four groups possess symmetric arohanam and avarohanam (use the same swaras in the arohanam and the avarohanam) while the rest use asymmetric scales.

Composers and thier identifiers

The following list contains the names of a few composers and the identifiers used by them. The names are in no particular order.

Composer	Identifier
Sadasiva Brahmendra	Paramahamsa
Jayadeva	Jayadeva
Purandara Dasa	Purandara Vittala
Bhadrachalam Rama Dasa	Bhadrachala Rama
Narayana Theerthar	Narayana Theertha
Annamacharya	
Bhodendra	Bhodendra
Thyagaraja	Thyagraja
Muthuswamy Dikshithar	Guruguha
Shyama Shastry	Shyama Krishna
Maharaja Swathi Thirunaal	Padmanabha, Kamalanabha
	and other synonyms

Harikesanallur Muthiah Bhagavathar	Harikesapura
Papanasam Sivan	Ramadasan
Patnam Subramanya Iyer	Venkatesa, Venkateswara
Veenai Kuppaiyar	Gopaladasa
Mysore Vasudevacharya	Vasudeva
Tirupathi Narayanaswamy	Tirupathi (pura) Varada Venkatesa
Gopalakrishna Bharathi	Balakrishna
Vedanayagam Pillai	