Tana Varnam-s: An Entry into *Rāga* Delineation in Carnatic Music

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*R**āga* delineation in either Hindustani or Carnatic music continues to be a major topic in Indian music. Previous research has shown that the nature of *rāga* is complex, multi-faceted, and difficult to generalize into a single definition. Almost any given *rāga* is much more than an ascending and descending scale and a few other special features or phrases. More scholarly approaches list features (called *lakshana-s*) that may or may not be attributes of a particular *rāga*. While detailed transcriptions of Indian music can help fill in the gap between description and practice, the lack of a general methodology for describing *rāgas* as well as detailed documentation of how *rāgas* are taught have made it difficult to progress further. In this paper, I will offer a method for analyzing *rāgas* from performances of compositions and improvisations; however, the music I shall study will come from pedagogical aids such as recordings and notation. In this way, I can study *rāga* delineation directly from the way music is taught. Since I am working within the Carnatic tradition of Indian music, many of my results may not transfer completely into Hindustani music. This is because these two traditions are more different than is often acknowledged in introductory accounts of Indian music, and that few scholars and performers are equally familiar with both.

I will begin by studying the pedagogy of an important type of Carnatic composition, the *tana-varnam*. A *tana-varnam*,[1] or simply *varnam*, is—among other things[2]—a composition explicitly designed to present the *rāga* in which it is composed in all of its subtleties of ornamentation, special phrases, and overall pitch movement; it teaches the student how to sing, perform, and eventually improvise in its *rāga*, as well as serving as sort of a *rāga* dictionary, on which other compositions and performances are based. Because of this feature, the study of the teaching of *varnams* supported by transcription offers direct and pertinent data for determining *rāga* delineation. In the last part of this paper I show what results when I enter this data into a computer program whose output shows typical paths through the notes of a *rāga*.

Indian music is usually taught orally one-on-one, from teacher to student. In the Carnatic tradition, graded exercises in the form of compositions are used to teach the basics. These compositions are said to have been composed and/or collected by Purandaradasa (1484-1564), recognized as the founder of Carnatic music. All beginning students must memorize and master these elementary solfège exercises called *sarale* (*svarali*), *janti* (*varase*), and *tāla-alankaras* as well as songs called *pillari gitas*.[3] Then the student is taught more complicated pieces ending the pedagogical sequence with

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[1] The prefix *tana* is used to distinguish this type of *varnam* from *pada-varnams* found in Indian dance. Since we will not be looking at *pada-varnams*, I will simply use the term *varnam*.

[2] *Varnams* are used to perfect vocal style and promote a proper control of rhythm. *Varnams* are often practiced or performed at double speed to this end. In such cases, the *tāla* does not speed up; it is counted (with *krīya*) at tempo, with the performance of the composition at double speed.

[3] Much of this pedagogical literature is composed in the *rāga Mayamalavagaula* and in all the major *tālas*. See Kumar, K. and Stackhouse, J. *Classical Music of South India: Karnatic Tradition in Western Notation* (Stuyvesant, N.Y.: Pendragon Press, 1987)

varnams and *swarajatis*.[4] Only after this pedagogical sequence is complete is the student taught items in the concert repertoire and improvisation.

But in recent years other pedagogical settings have been employed, such as teaching students in groups and using media such as notation and recordings, often over the Internet. An example of such pedagogical aids is the six-cassette recording called "Carnatic Lessons (Nottuswara Sahitya and *Varnams*)" sung and with commentary (in English) by S. Rajeswari, a lecturer in Tamil Nadu Government Music College. The tapes include the teaching sessions of 13 well-known *varnams*. Another example is the book "Ganamrutha Varna Malika" by A. S. Panchapakesa Iyer, a collection of forty-one *varnams* in Indian notation, also in English. The set of tapes and the publication provide data for an inquiry into *rāga* structure in two *varnams* found in both pedagogical sources: "Viriboni" in *Bhairavī rāga* and *Ata tāla*, and "Vanajakshiro" in *Kalyani rāga* and *Adi tāla*. (See Example 1(a).)

But before we get to these pedagogical sources, let me briefly outline the musical form of a typical *varnam*. A *varnam* is usually based on a single *rāga* and set in one of two *tālas*, either *Adi tāla* of 8 beats divided 4, 2, 2, or *Ata tāla* of 14 beats, divided 5, 5, 2, 2. A *varnam* has two basic sections, the second sung (or played on an instrument) in a faster tempo than the first. Example 1(b) gives the complete formal design of a *varnam*; however, I will only be examining the first section of *varnams*, consisting of the *pallavi* and *anupallavi* sections, which have text, and the concluding *mukthaya swaram* section, which is sung in Indian solfège called *sargam*.

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[4] While these two types of compositions are part of the pedagogical sequence, they are often performed in concert, with a *varnam* as the first or second piece on the concert.

Example 1(a). *Varnams* studied in this paper

"Vanajakshiro" in *Kalyani raga* and *Adi tala* (8 beats = 4 + 2 + 2) composed by Ramnad Sreenivasa Iyer (1860-1919)

"Viriboni" in *Bhairavi raga* and *Ata tala* (14 beats = 5 + 5 + 2 + 2) composed by Pacchimirium Sree Adiyappiyer (18th century)

Example 1(b). General form of the *Varnam*

> **A: Purvanga** (first part)
> > pallavi (with text, two or more cycles of tala)
> > anupallavi (with text, two or more cycles of tala)
> > mukthaya swaram (sargam, two or more cycles of tala)
> > pallavi (opening phrase)
>
> **B: Uttaranga** (second part)
> > ettugada pallavi (carana) (with text)
> > chitti swaram 1 (sargam)
> > ettugada pallavi
> > chitti swaram 2 (sargam)
> > ettugada pallavi
> > chitti swaram 3 (sargam)
> > . . .
> > chitti swaram n (sargam)
> > ettugada pallavi
>
> > (sargam is Indian solfège.)

Now let us look at the Indian notation of one of two *varnams* we shall study, "Vanajakshiro" in *Kalyani rāga* and *Adi tāla*. The first page of three from Panchapakesa Iyer's book is shown in Example 2. The notation is headed by the name of the *rāga*, its parent scale, *tāla*, and composer. The ascending and descending movement of the *rāga* in *sargam* is given next, followed by the Sanskrit texts of the *pallavi*, *anupallavi* and *charanam* sections. The composition follows in *sargam*. The letters stand for the vocables Sa, Ri, Ga, Ma, Pa, Dha, Ni, the names of the seven notes of the scale. This corresponds to Do, Ri, Mi, Fa, Sol, La, Ti; however, note that neither the exact pitches

Example 2. Indian notation of "Vanajakshiro"

6. VANAJĀKSHIRŌ

Rāgam : KALYĀNI — 65th Mēla Karthā
Tālam : ĀDI — Rāmnād Sreenivāsa Iyengār

Ărōhanam : S R₂ G₂ M₂ P D₂ N₂ Ṡ **Avarōhanam** : Ṡ N₂ D₂ P M₂ G₂ R₂ S
Pallavi : Vanajākshirō ee virahamōrvanē Vāsudēvuni thōdi dēvē
Anupallavi : Vinavē Nāgapuramuna Velayu Soundara rājuni
Charanam : Nilupa rāni mōhamāyē

Pallavi:

Ṡ	Ṡ	,–	Ṡ	N	D–	Ṙ	Ṡ	N–	N	D–	D	P	M	G	M
Va	na	–	jā	–	–	kshi	–	–	rō	–	–	–	–	ee	–

P	D	N	D	,–	Ṙ	Ṡ	N	D	P	M–	G	M	P	D	N
vi	–	–	ra	–	ha	–	–	mō	–	–	rva	–	–	–	nē

Ṡ	Ṙ	G̈	Ṙ	Ṡ–	N	Ṡ	Ṙ	Ṡ	N–	Ṙ	Ṡ	N–	D	N	D
Vā	–	–	–	–	su	–	–	–	–	dē	–	–	vu	–	–

N	,	,	,	,	,–	Ṡ	N	D	P	M–	G	M	P	D	N
ni	–	–	–	–	–	thō	–	di	–	–	dē	–	–	–	vē

Anupallavi:

P	,	M	G	N	D	,–	G	D	P	,	M	G	R	S	N̤
vi	–	–	–	–	na	–	–	–	ve	–	–	Nā	–	ga	–

nor the intervals between them are given in the notation, but inferred from the *rāga* of the composition. The *rāga* of this *varnam* is *Kalyani* with its fourth degree, Ma, sharped. Thus the pitch material for this *rāga* is akin to the notes of the Lydian mode.[5]

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[5] In the notation of the other *varnam*, the *rāga* is *Bhairavī*, which takes a flat third and seventh degree, and both a flat and natural sixth.

Rhythm is notated by symbols, either *sargam* letters or lines (indicating rests or sustained pitches), each equal to a quarter of a beat. The layout of the notation shows a cycle of the *tāla* of the *varnam* in two lines, the first line comprises sixteen symbols equaling the first four-beat division of the *tāla*, and the second line gives the last two-beat divisions of eight symbols each, separated by a vertical line. Below the symbols is the text of the music.

Obviously, Indian notation is schematic, leaving out many important features of the music.[6] The main function of the notation is mnemonic, to aid memorization. Nevertheless, the notation gives the basic information of a composition, which, when combined with the performance practices of *rāga* and *tāla* should yield something like the performed composition. We can therefore say the notation is phonemic rather than phonetic.

In Example 3 is the Western equivalent of the Indian notation in Example 2. Please listen to the following recording of the *pallavi* section of "Vanajakshiro" so you can compare the performance with the Western notation.

Any attentive listener will have noted a great discrepancy between the recording and the notation. This is not due to mistakes in the notation, but due to the nature of notes in Carnatic music. This renders Western habits of reading pitch notation ineffective, so the notation seems foreign to the heard music. As I will demonstrate later, this makes it difficult for the inexperienced Western listener to parse and hierarchize Carnatic pitch relations correctly.[7]

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[6] Perhaps one can compare it to lead sheet used in Western popular music and jazz.

[7] This is not a major problem in hearing Hindustani music, and is therefore one of the salient differences between Carnatic and Hindustani music.

Example 3. Western translation of Indian notation

Vanajakshiro

Ramnad Sreenivasa Iyengar

Va-na - ja - kshi - ro———— ee— vi - ra - ha - mo—— rva - ne

Va - su - de - vu - ni - tho - di——— de - ne

Anupallavi

Vi - na - ve— Na - ga - pu - ra - mu - na———

Audio Example 1: "Vanajakshiro"

But before dealing with this pitch issue, let us listen to a portion of the tapes, to see how *varnams* are taught. The next recording documents the beginning of Rajeswari's teaching of the other *varnam*, "Viriboni," in *Bhairavī rāga* and *Ata tāla*. (I have deleted a bit of the exposition for reasons of space.)

Audio Example 2

You will note that Rajeswari sings manageable parts of the *varnam* with the students repeating what they hear as best they can, which varies from adequate to good. This means that although the composition is sung in time, the *tāla* is suspended. Another

important deviation from the performed composition is that Rajeswari sings the *varnam* using *sargam* rather than the text. This makes it clear what pitch is in play from note to note, even though the articulation of these pitches seems highly ornamented. I say "seems highly ornamented" because the notes in Indian music practice are not strictly distinguished from their articulation, which involves many different kinds of precisely timed slides and oscillations.[8] After Rajeswari has taught the smaller phrases of a section of the *varnam*, she goes back to repeat these phrases joined together to make longer passages with the students singing each longer phrase after her. On a third or fourth pass she sings the entire section with the students following suit. The next phase is to return to repeat this process of grouping a section of the *varnam* into smaller parts and building up to the whole section, but now singing the text of the *varnam* rather than the *sargam*. Only after this is done, does she move on to the next section of the *varnam*. Since "Viriboni" is a long composition, it takes over an hour to complete the teaching.

From the tape it is clear that this teaching involves no verbal discourse, only the rote memorization of the composition. This is traditional music pedagogy; however, in a less idealized teaching situation, the teacher will not go on to the next phrase until the student has completely mastered all the details of the one at hand. This may involve many repetitions of the phrase by the teacher, each followed by the student.[9] But even in this non-verbal setting, it is interesting to study how the teacher groups the *varnam* into parts, which suggests how expert musicians mentally hierarchize this music.

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[8] These types of pitch movements also distinguish Carnatic from Hindustani music. In the latter genre the movements are slower, but no less precise, and the movement that oscillates around a pitch center is extremely rare.

[9] Nevertheless, some teachers will lecture on a piece they are teaching, demonstrating all the intricate details of each phrase with verbal commentary.

Using Panchapakesa Iyer's notation translated into Western musical notation, in Examples 4 and 5 I show Rajeswari's pedagogical partitioning of each *varnam*. In these examples, brackets above the staff shows the grouping of the *varnam* when she sings it using *sargam*, and the brackets below show the grouping when there is text. In the case of the *mukthaya swara* sections, there are no brackets below the staff since this section's text is *sargam*.

Example 4 notates Rajeswari's nested partitioning of the *Kalyani varnam*, "Vanajakshiro." The example shows there are different groupings when Rajeswari teaches the *varnam* with *sargam* versus with the text; however, in each case, the partitioning is well formed from the smallest phrases to the longest. In the *sargam* partitioning, the groupings are first equal to four beats each, half the length of the *tāla Adi*. On the next pass through the *varnam's* sections, the groupings are complete *tāla* lengths—then two *tāla* lengths, the length of each section of the *varnam*. The texted partitioning is more variously partitioned, especially on the most local level. It tends to follow the setting of the text, but doesn't always break at word boundaries, but at syllables. Looking at the top line of Example 4, we see the text groupings are of the following lengths in eighth notes: 6, 8, 7, 6, and 5. This teaches the student how the syllabification conflicts with the *tāla* beats and divisions, in a subtractive series of durations following the initial duration of six eighth-notes. The groupings of the second line are 10, 12, and 10 eighth notes. Each of these groupings is broken exactly in half by the syllables; thus we have 5 + 5, 6 + 6, and 5 + 5. The last grouping is a little more complicated, being divided by the syllables into subgroupings of 2 + 3 and 4 +1 eighth notes. We see that pedagogical partitioning of the *varnam* shows the *tāla* structure in the

Example 4. Pedagogical partitioning of "Vanajakshiro"

sargam grouping, and the details of rhythmic syncopations and symmetries in the texted groupings—all done without words.

Example 5 shows a similar situation in Rajeswari's teaching of "Viriboni"; however, there are some differences. This *varnam* is more complex, longer, and more difficult to sing than "Vanajakshiro." As in *Ata tāla varnams*, the sections of the composition always begin on beat three. (This starting point is called the *eduppu*.) This complicates the pedagogical partitioning, so upon repetition we return not to the first beat of the *tāla*, but the *eduppu*. I've not notated all the consequences of this issue, but it affects some of the lines of Example 5. The most local level of the *sargam* partitioning does not always follow the 5, 5, 2, 2 beat structure of the *tāla*, partly because of the placement of the *eduppu* on beat three, near the middle of the first division of the *tāla*. The local grouping of the texted partitioning also shows hidden rhythmic symmetries and patterns, but there is not sufficient space to point any of these out at present.

Now I turn to the pitch structure of these *varnams*. Because the *varnams* are taught using *sargam*, there is no confusion about the function of pitches one hears in a performance using the text. Furthermore, the absence of a drum accompaniment, used in concert performances, helps one hear the notes more clearly.

Please refer to Example 6(a). Here you have the Western version of Panchapakesa Iyer's notation of the *pallavi* section of "Vanajakshiro" coordinated with fairly accurate transcriptions of the actual pitch-movements of each note. The top of the two handwritten lines gives the transcription of the varnam as sung with *sargam*, the bottom as sung with the text. (Brackets show the pedagogical partitioning of the music.) The two parallel transcriptions correspond to a good extent, but there are some differences since the text is

Example 5. Pedagogical partitioning of "Viriboni"

Example 5 (cont'd).

set melismatically so that the notes glide into each other more freely. I should point out here that these transcriptions actually represent the details of the composition, which are meant to be precisely learned and performed. Thus, Panchapakesa Iyer's notation is simply a shorthand version of the composition, not a prototype from which the performer may paraphrase freely and differently from occasion to occasion.

Let's look in detail at the first system of the music in Example 6(a). (First, I should point out that the sixth note of Panchapakesa Iyer's notation, a Ri, deviates from the Ni in Rajeswari's sung version. I have circled the deviant Ri to show this discrepancy. There are very few other differences between the notation and performance otherwise.) The two lines of transcriptions correspond for the most part, so I will comment mainly on the top,

Example 6(a). Transcription of the *pallavi* of "Vanajakshiro"

Example 6(b). Transcription of the *pallavi* of "Vanajakshiro" continued

sargam line in my discussion. Here is a recording of the *sargam* version of the top system. Remember to attend to the top of the two transcriptions.

Audio Example 3

The pitch of the first three notes, Sa, the *rāga* tonic, is sustained without pitch modulation; however, it is preceded by a short glide, which is often found before a sustained pitch. The next four notes, Ni, Dha, Ni, Sa are modulated. The two Nis are performed the same way, sustained at the level of Sa, but ending on the pitch of Ni. The Dha is executed as a glide from Sa to Dha. Thus these notes might appear to embellish Sa, but this is not a correct way to characterize them. They are not embellishments of some other pitch, but just ways of performing Ni and Dha in this *rāga*. The next pitches Ni, Ni, Dha, Dha, are performed in the same ways as before. Pa is performed without modulation, followed by Ma, Ga and Ma. The first Ma is performed as a motion from the level of Pa, quickly touching the level of Ma, and returning to the level of Pa; even though we may hear something like a mordent on Pa, this is a legitimate articulation of Ma. The articulation of Ga is an oscillation from Pa to Ga and back, followed by a Ma performed like the first Ma. If you look at the second line of the transcription at this point, this motion from Ma through Ga to Ma is performed a little differently. Here the Ma is like a trill on Ma; after this, the motion from Ga to Ma is collapsed into double motion from the level of Pa to the level of Ga. The reason this is possible is that Ma may be performed as a slide from the level of Ga to Pa, although this articulation of Ma is relatively rare in this *rāga*.

The second system of the transcription in Example 6(a) shows a different way Dha can be performed in this *rāga*. Look at the fourth note. Here Dha is two counts long and performed as a timed oscillation from Dha to a slightly higher pitch, notated as low B-flat. All the rest of the notes on this line are performed as they were on the first. Here is a recording of the second line of the transcription:

Audio Example 4

The third system of Example 6(a), which is the first half of the second line of the *pallavi* section of the composition, brings in two new notes: high Ri and Ga. Ri is sung with a quick slide from the level of Ga down to Ri. Ga is performed without modulation, unlike its counterpart an octave lower. A new version of Ni occurs as the sixth note on this system. It moves from the level of Pa up to Sa, passing the level of Ni. Note that in the texted transcription, the Ni is sounded after the glide is completed, making the Ni resemble its previous articulations as a note starting on the level of Sa, touching Ni only at the end. Another version of Ni occurs on the texted line, as a trill on Ni to Sa.

Here is a recording of the third line of the transcription:

Audio Example 5

The fourth system of the transcription is given in Example 6(b). We see and hear Ni as a long note, performed as a motion from Sa to Dha and back, then an oscillation from Sa to Ni, with Sa receiving more time than Ni. Once again, this note is not a Sa

oscillating with a lower neighbor, but a Ni oscillating with a higher neighbor! This emphasis on Ni is a feature of this composition, which tends to have the note Ni sung with a text that includes the syllable Ni at that point. This type of south Indian text setting is called *swaraksharam*.

Here is a recording of the fourth line of the transcription:

[*Audio Example 6*](#)

Let us now look at "Viriboni" to see how its notes are modulated. Here I use my transcription of the *Mukthaya Swaram* section. See Example 7.

The section starts on beat 3 of the *tāla*, the *eduppu*, written on the top system of the example. Looking at the first grouping of music, from beat 3 through beat 5, we see that in this *rāga*, *Bhairavī*, one way to perform Ga is as a slide or oscillation from the level of Ma to Ri, sometimes resting on Ga at the end. Ni is usually performed similarly, with a glide or oscillation from Sa to Dha. However, there are two scale degree Dha-s in the *rāga*: in ascending passages natural Dha is used, in descending passages flat Dha is used. The presence of the natural Dha in the modulation of Ni can confuse listening, since it can be heard as a motion to Dha not as a Ni. Similarly, an oscillation on Ga from Ri to Ma can make that note sound as if it were a succession of movements from Ri to Ma and back; however, such confusions go away if one listens to what *sargam* syllable is sung as you hear the pitch movements.

Transcription of the *mukthaya swaram* section of "Viriboni"

Here is the audio corresponding to these first three beats of the section:

Audio Example 7

Now we follow Example 7 further, from beats 6 through 14 of the *tāla*. Here we see that low Ma and Ga are unmodulated, while Dha is performed as flat Dha oscillating with G; this might sound like a trill on Pa, but it is not. The next note Ni is performed as an oscillation between Ni and natural Dha, a different modulation of Ni than before and after. Note the flat Dha is used in ascent, which locally deviates from the note syntax of this *rāga*; however, a local phrase like this is permitted in *Bhairavī*. On the second system of Example 7, in the first of the 2/2 measures, we see a Ga that oscillates from Ga to the level of Ri. This is followed by a Ma that does something similar, touching natural Ga for an instant. At the beginning of the second 2/2 measure, flat Dha is performed by a

slide up from Ri to Dha. After the next note Pa, we hear Ma performed as a slide from Pa

to natural-Ga immediately followed by Dha performed as a slide from Ma to Dha. All

these are legitimate modulations of these notes. The measure ends with a Ni performed as

an oscillation from Ni to natural Dha. Here is the entire passage we've just examined:

Audio Example 8

Space does not permit any more discussion of the details of the pitch movements in

the *rāgas* of the *varnams*; however, I have provided a summary of all the pitch

movements in the next examples. Example 8 shows all the different ways notes are

modulated in *Kalyani* as found in "Vanajakshiro." The scale degrees are written in order

from bottom to top with each of the modulations of a scale degree given horizontally.

(Note that a particular modulation may occur at only one octave register of a scale

degree.) In Example 8, we see that there are six ways Sa is performed, numbered 1 to 6.

Thus we can say there are six distinct Sa-s in this performance of the *Kalyani varnam*.

Looking at the extreme cases, there are four Ma-s and eleven Dha-s. Most of the other

scale degrees have around seven modulations. The sixth Ni, the seventh Dha and the fifth

Sa (all starred) have exactly the same modulations, so only context will distinguish them

as different scale degrees.

Example 9 shows a similar list for *rāga Bhairavī* as performed in "Viriboni."

Here there are twenty-four Ni-s, twenty Ga-s, fifteen flat Dha-s, and fifteen Ma-s. The

scale degree with the least variety of modulations—three—is the natural Dha, which

greatly contrasts from the flat Dha. This gives a reason why this *rāga* is classified as a

Example 8. Note modulations in *rāga Kalyani*

Example 9. Note modulations in *rāga Bhairavī*

member of the parent scale *Natabhairavī*, with a flat third, sixth and seventh degree, rather than the parent scale *Harakharapriya*, with only flat third and seventh. Thus the foreign (*bashanga*) note in *rāga Bhairavī* is the natural sixth.

These charts can be used with the Indian notation to notate much more precisely the modulations used in a composition. One simply adds a superscript corresponding to the modulations on the charts to the Indian *sargam* letters in the notation. Example 10 shows this addition to the notation of "Vanajakshiro" of Example 2.

The two charts of Examples 8 and 9 make it clear that a *rāga* is not comprised only of notes corresponding to a scale degree, but of many more "notes" distinguished by octave register and modulation. So *Bhairavī* doesn't have just 8 notes, but 103! (Or, we can call each of these, different *pitch-modulations*.)[10] One may object to say many of

Example 10. Re-notation of the *pallavi* section of "Vanajakshiro"

S^1	S^1	$,-$	S^1	N^2	D^9-	N^2	S^1	N^2-	N^2	D^9-	D^9	P^1	M^1	G^7	M^1
Va	na	–	ja	–	–	skhi	–	–	ro	–	–	–	–	ee	–

P^1	D^9	N^2	D^3	$,-$	N^4	S^1	N^2	D^9	P^1	M^1-	G^7	M^1	P^1	D^9	N^2
vi	–	–	ra	–	ha	–	–	mo	–	–	rva	–	–	–	ne

S^1	R^5	G^1	R^5	S^1-	N^6	S^1	R^5	S^1	N^2-	R^2	S^1	N^2-	D^9	N^2	D^9
Va	–	–	–	–	su	–	–	–	–	de	–	–	vu	–	–

N^5	$,$	$,$	$,$	$,$	$,-$	S^5	N^2	D^9	P^1	M^1-	G^7	M^1	P^1	D^9	N^2
ni	–	–	–	–	–	tho	–	di	–	–	de	–	–	–	ve

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[10] The same modulation on notes in different octave registers are considered distinct, since, in Indian music, even straight pitches may have different functions in different octave registers. Of course, we may group notes into pitch-classes, or having the same modulations, called modulation-classes. In fact, some modulation-classes, called *alankara* (ornaments), are listed in various treatises.

these modulations are context sensitive so these so-called notes are not independent—to which I answer, just so! The analysis of a *rāga* is based on the patterns of notes, not just a list of its notes; otherwise the *rāga* would simply be defined as an unordered set of pitches. However, the description of a *rāga* as different successions of scale degrees that doesn't take into account the modulations of each scale degree would promote successions of modulations that would not be allowed in a particular *rāga*—or even worse, successions that would not be able to be sung or played. Therefore, a list of the permitted two-note successions of all 103 notes in *Bhairavī* as found in "Viriboni" would be a quite definitive description of the *rāga*. However, such a list will be unwieldy. Moreover, a list of pairs does not list the three, four and more note successions that form characteristic phrases that immediately identify *Bhairavī* to the knowledgeable listener. Hence, the list of two-note successions is fed into my computer program, called MinCyc that constructs a graph of all possible successions of the notes.[11] Such a graph usually is too intricate to show much more than sheer complexity if printed out in two dimensions, so examining it as a whole usually is not useful. However, MinCyc, will print out all the minimal cycles of the graph, thus revealing the legal successions in the input data. In this way, this program along with others generates the characteristic phrases of a *rāga*, which are permissible, but not always uniquely associated with this *rāga*. Some of these phrases show up in the composition from which the data is derived; these and others could be used in improvisations on the *rāga* of the composition.

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[11] A complete description of the construction of graphs, their minimal cycles and their use in various branches of music theory is found in my article, "Some Musical Applications of Minimal Graph Cycles," published in *Theory and Practice*, 35, 2010. While this is not specifically a paper on Indian music, I do use the minimal cycle graph methodology to analyze the melodic structure of the Hindustani *rāga*, *Shree*.

Example 11 lists the eleven minimal cycles for the *pallavi* section of "Vanajakshiro." I've transcribed each note cycle. You will have heard and seen these successions in my previous discussion of that section. It is interesting that these cycles are short—of one, two or four notes. The numbers next to each cycle indicate the number of times it was found in the graph of the *pallavi* section. This statistic suggests how common each cycle is to the music data input.

The MinCyc program not only shows which cycles are generated by a *rāga* but can be used to analyze a composition or improvisation. Example 12 gives a comparison of the three sections of "Vanajakshiro" we have studied. We see that as the composition progresses, each section becomes increasingly fecund; the number of cycles and their lengths augment. On the other hand, judging from the number of repetitions of cycles, the number of quite characteristic (that is, frequent) cycles somewhat decreases.

The analysis of "Viriboni" and its *rāga* shows much greater complexity.[12] The *tāla* is longer, and more lines are devoted to each section of the composition. The *pallavi* section of "Viriboni" has 105 distinct cycles varying from one to fifteen notes, some of which are

Example 11. The eleven minimal cycles for the *pallavi* of "Vanajakshiro"

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[12] This *varnam* is considered a masterpiece and is often performed on concerts.

Example 12. Statistics for the first part of "Vanajakshiro" (*Kalyani*)

pallavi				anupallavi				muthaya swaram			
#cyc	tot	len	tot	#cyc	tot	len	tot	#cyc	tot	len	tot
1	2	1	2	1	5	1	1	1	8	2	6
2	2	2	8	2	7	2	8	2	4	3	2
4	1	4	1	3	1	3	2	3	4	4	5
5	1			4	4	4	3	4	13	5	6
6	1			6	5	5	3	10	3	6	6
9	2			7	1	6	2			7	3
10	1			12	1	7	3			8	3
30	1					8	1			9	1
						9	1				
	11		11		25		25		32		32

#cyc = number of repetitions of a particular cycle in the output of MinCyc
len = number of notes in a particular cycle
tot = number of cases of the items in the column to the left.

found in the graph of the section 147 times. Example 13 shows the longest and most replicated cycles in the *pallavi*. By contrast, the *Mukthaya* section of "Viriboni" has only 57 distinct cycles. They vary from one to ten notes, and many have few replications. The longest cycle, and the cycle with most replications is found in Example 14.

Before turning to my conclusions, please listen to a performance of the first half of "Viriboni" sung by a master musician, so you can hear it as the music it truly is. The singer is Neyvelli R. Santhanagolpalan, accompanied by violin, mridangam (drum) and kanjira (tambourine).

Audio Example 9

In conclusion, I have attempted to provide a new and I think better way to delineate *rāgas* by basing it on the successions of modulations of *rāga* scale degrees. I

Example 13. The longest and most replicated minimal cycles in the *pallavi* of "Viriboni"

Example 14. The longest and most replicated minimal cycles in the *mukthaya swaram* section of "Viriboni"

could have described this as examining the sequences of different ornamentations of *rāga* scale degrees, but this description hierarchizes the scale degree over the modulation. Even if it is traditional, and therefore easier to speak of note modulation in this way, we have seen that the modulations will often not distinguish one scale degree (*swara*) from another (unless the note name is sung at the same time). So, thinking of scale degrees embellished by ornaments really doesn't touch the heart of *rāga*, in which the successions of modulations is more definitive than the successions of scale degrees. The MinCyc program not only helps us determine these successions, but it can be used to help analyze the process and form of a composition or an improvisation.

The use of pedagogical materials to obtain the data for *rāga* delineation solves a basic problem—that data derived from phonetic transcriptions of performances may only model that naïve empiricism based on an outsider's hearing and conceptualization, which may be wrong and/or inappropriate from the point of view of the insider. Data based on performance practice and learning will bypass this problem. Even so, different teachers may teach the same *rāgas* with various degrees of competence and from different musical traditions. More studies using transcriptions will be necessary to confirm, refine and differentiate the results I have obtained so far.