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ABSTRACT

This paper deals with the study of formulation of special family of 3-tuples (a,b,c) such that the product of any two elements of the set added with their sum is a perfect square.

Keywords— Diophantine 3-tuples; negative pellian equation; integer solutions.

I. Introduction

The problem of constructing the sets with property that product of any two of its distinct elements is one less than a square has a very long history and such sets have been studied by Diophantus. A set of m distinct positive integers $\{a_1, a_2, a_3, ...a_m\}$ is said to have the property $D(n), n \in Z - \{0\}$ if $a_i a_j + n$ is a perfect square for all $1 \le i < j \le m$ or $1 \le j < i \le m$ and such a set is called a Diophantine m-tuple with property $D(n)$. In this context, one may refer [1-4].

A set of m distinct positive integers $(a_1, a_2, ..., a_m)$ is said to be Dio m-tuple with property $D(n)$ if $a_i a_j + (a_i + a_j) + n$ or $\mathrm{a_i a_j} - (\mathrm{a_i} + \mathrm{a_j}) + \mathrm{n}$ is a perfect square for all $1 \le i < j \le m$ or $1 \le j < i \le m$. In particular, one may refer [5-8] for problem on special dio-3-tuples.

This paper aims at constructing sequences of 3-tuples where the product of any two elements of the set added with their sum is a perfect square.

II. Method of Analysis

Sequence 1:

Let $a = 2k^2 + 6k + 4, c_0 = 8k^2 + 16k + 9$

It is observed that

$$ac_0 + a + c_0 = \left(4k^2 + 10k + 7\right)^2$$

Let c_1 be any integer such that

$$(a+1)c_1 + a = \alpha^2 \qquad (1)$$

$$(c_0+1)c_1 + c_0 = \beta^2 \qquad (2)$$

Eliminating c_1 between (1) and (2), we have

$$(c_0+1)\alpha^2 - (a+1)\beta^2 = (a - c_0) \qquad (3)$$

Introducing the linear transformations

$$\alpha = X + (a+1)T \ , \ \beta = X + (c_0+1)T \qquad (4)$$

in (3) and simplifying we get

$$X^2 = (a+1)(c_0+1)T^2 - 1$$

which is satisfied by $T = 1$, $X = 4k^2 + 10k + 7$

In view of (4) and (1), it is seen that

$$c_1 = 18k^2 + 42k + 28$$

Let c_2 be any integer such that

$$(a+1)c_2 + a = \alpha^2 \qquad (5)$$

$$(c_1+1)c_2 + c_0 = \beta^2 \qquad (6)$$

Eliminating c_2 between (5) and (6), we have

$$(c_1+1)\alpha^2 - (a+1)\beta^2 = (a - c_1) \qquad (7)$$

Introducing the linear transformations

$$\alpha = X + (a+1)T \ , \ \beta = X + (c_1+1)T \qquad (8)$$

in (7) and simplifying we get

$$X^2 = (a+1)(c_1+1)T^2 - 1$$

which is satisfied by $T = 1$, $X = 6k^2 + 16k + 12$

In view of (8) and (5), it is seen that

$$c_2 = 32k^2 + 80k + 57$$

Let c_3 be any integer such that

$$(a+1)c_3 + a = \alpha^2 \tag{9}$$

$$(c_2+1)c_3 + c_0 = \beta^2 \tag{10}$$

Eliminating c_3 between (9) and (10), we have

$$(c_2+1)\alpha^2 - (a+1)\beta^2 = (a - c_2) \tag{11}$$

Introducing the linear transformations

$$\alpha = X + (a+1)T \ , \ \beta = X + (c_2+1)T \tag{12}$$

in (11) and simplifying we get

$$X^2 = (a+1)(c_2+1)T^2 - 1$$

which is satisfied by $T = 1$, $X = 8k^2 + 22k + 17$

In view of (12) and (9), it is seen that

$$c_3 = 50k^2 + 130k + 96$$

The repetition of the above process leads to the generation of sequence of 3-tuples whose general form is given by (a, c_{s-1}, c_s) where

$$c_{s-1} = (2s^2 + 4s + 2)k^2 + (6s^2 + 8s + 2)k + (5s^2 + 4s) \ , \ s = 1, 2, 3, \ldots$$

A few numerical examples are presented in Table 1 below:

Table 1: Numerical Examples

k	(a, c_0, c_1)	(a, c_1, c_2)	(a, c_2, c_3)	(a, c_3, c_4)
2	(24, 73, 184)	(24, 184, 345)	(24, 345,556)	(24, 556,817)
3	(40, 129, 316)	(40, 316, 585)	(40, 585, 936)	(40, 936, 1369)
4	(60, 201,484)	(60, 484,889)	(60,889,1416)	(60,1416,2065)
5	(84,289,688)	(84,688,1257)	(84,1257,1996)	(84,1996,2905)

Sequence 2:

Let $a = 1, c_0 = 2k^2 - 2k$

It is observed that

$$ac_0 + a + c_0 = (2k-1)^2$$

Let c_1 be any integer such that

$$(a+1)c_1 + a = \alpha^2 \tag{13}$$

$$(c_0+1)c_1 + c_0 = \beta^2 \tag{14}$$

Eliminating c_1 between (13) and (14), we have

$$(c_0+1)\alpha^2-(a+1)\beta^2=(a-c_0) \tag{15}$$

Introducing the linear transformations

$$\alpha=X+(a+1)T\ ,\ \beta=X+(c_0+1)T \tag{16}$$

in (15) and simplifying we get

$$X^2=(a+1)(c_0+1)T^2-1$$

which is satisfied by $T=1$, $X=2k-1$

In view of (16) and (13), it is seen that

$$c_1=2k^2+2k$$

Let c_2 be any integer such that

$$(a+1)c_2+a=\alpha^2 \tag{17}$$

$$(c_1+1)c_2+c_0=\beta^2 \tag{18}$$

Eliminating c_2 between (17) and (18), we have

$$(c_1+1)\alpha^2-(a+1)\beta^2=(a-c_1) \tag{19}$$

Introducing the linear transformations

$$\alpha=X+(a+1)T\ ,\ \beta=X+(c_1+1)T \tag{20}$$

in (19) and simplifying we get

$$X^2=(a+1)(c_1+1)T^2-1$$

which is satisfied by $T=1$, $X=2k+1$

In view of (20) and (17), it is seen that

$$c_2=2k^2+6k+4$$

Let c_3 be any integer such that

$$(a+1)c_3+a=\alpha^2 \tag{21}$$

$$(c_2+1)c_3+c_0=\beta^2 \tag{22}$$

Eliminating c_3 between (21) and (22), we have

$$(c_2+1)\alpha^2-(a+1)\beta^2=(a-c_2) \tag{23}$$

Introducing the linear transformations

$$\alpha=X+(a+1)T\ ,\ \beta=X+(c_2+1)T \tag{24}$$

in (23) and simplifying we get

$$X^2=(a+1)(c_2+1)T^2-1$$

which is satisfied by $T=1$, $X=2k+3$

In view of (24) and (21), it is seen that

$$c_3 = 2k^2 + 10k + 12$$

The repetition of the above process leads to the generation of sequence of 3-tuples whose general form is given by (a, c_{s-1}, c_s) where

$$c_{s-1} = 2k^2 + (4s-6)k + (2s^2 - 6s + 4),\ s = 1,2,3,...$$

A few numerical examples are presented in Table 2 below:

Table 2: Numerical Examples

k	(a,c_0,c_1)	(a,c_1,c_2)	(a,c_2,c_3)	(a,c_3,c_4)
2	(1, 4, 12)	(1, 12, 24)	(1, 24, 40)	(1, 40, 60)
3	(1, 12, 24)	(1, 24, 40)	(1, 40, 60)	(1, 60, 84)
4	(1, 24,40)	(1, 40, 60)	(1,60, 84)	(1, 84, 112)
5	(1, 40, 60)	(1, 60, 84)	(1, 84, 112)	(1, 112, 144)

Sequence 3:

Let $a = 1, c_0 = 2k^2 + 2k$

It is observed that

$$ac_0 + a + c_0 = (2k+1)^2$$

Let c_1 be any integer such that

$$(a+1)c_1 + a = \alpha^2 \quad (25)$$

$$(c_0+1)c_1 + c_0 = \beta^2 \quad (26)$$

Eliminating c_1 between (25) and (26), we have

$$(c_0+1)\alpha^2 - (a+1)\beta^2 = (a - c_0) \quad (27)$$

Introducing the linear transformations

$$\alpha = X + (a+1)T\ ,\ \beta = X + (c_0+1)T \quad (28)$$

in (27) and simplifying we get

$$X^2 = (a+1)(c_0+1)T^2 - 1$$

which is satisfied by $T = 1$, $X = 2k+1$

In view of (28) and (25), it is seen that

$$c_1 = 2k^2 + 6k + 4$$

Let c_2 be any integer such that

$$(a+1)c_2 + a = \alpha^2 \quad (29)$$

$$(c_1+1)c_2 + c_0 = \beta^2 \quad (30)$$

Eliminating c_2 between (29) and (30), we have

$$(c_1+1)\alpha^2-(a+1)\beta^2=(a-c_1) \tag{31}$$

Introducing the linear transformations

$$\alpha=X+(a+1)T\ ,\ \beta=X+(c_1+1)T \tag{32}$$

in (31) and simplifying we get

$$X^2=(a+1)(c_1+1)T^2-1$$

which is satisfied by $T=1$, $X=2k+3$

In view of (32) and (29), it is seen that

$$c_2=2k^2+10k+12$$

Let c_3 be any integer such that

$$(a+1)c_3+a=\alpha^2 \tag{33}$$

$$(c_2+1)c_3+c_0=\beta^2 \tag{34}$$

Eliminating c_3 between (33) and (34), we have

$$(c_2+1)\alpha^2-(a+1)\beta^2=(a-c_2) \tag{35}$$

Introducing the linear transformations

$$\alpha=X+(a+1)T\ ,\ \beta=X+(c_2+1)T \tag{36}$$

in (35) and simplifying we get

$$X^2=(a+1)(c_2+1)T^2-1$$

which is satisfied by $T=1$, $X=2k+5$

In view of (36) and (33), it is seen that

$$c_3=2k^2+14k+24$$

The repetition of the above process leads to the generation of sequence of 3-tuples whose general form is given by (a,c_{s-1},c_s) where

$$c_{s-1}=2k^2+(4s-2)k+(2s^2-2s)\ ,\ s=1,2,3,...$$

A few numerical examples are presented in Table 3 below:

Table 3: Numerical Examples

k	(a,c_0,c_1)	(a,c_1,c_2)	(a,c_2,c_3)	(a,c_3,c_4)
2	(1,12,24)	(1, 24, 40)	(1, 40, 60)	(1, 60, 84)
3	(1,24,40)	(1, 40, 60)	(1, 60, 84)	(1, 84, 112)
4	(1,40,60)	(1, 60, 84)	(1, 84, 112)	(1, 112, 144)
5	(1,60,84)	(1, 84, 112)	(1, 112, 144)	(1, 144, 180)

Sequence 4:

Let $a=4,c_0=5k^2+4k$

It is observed that

$$ac_0 + a + c_0 = (5k+2)^2$$

Let c_1 be any integer such that

$$(a+1)c_1 + a = \alpha^2 \tag{37}$$

$$(c_0+1)c_1 + c_0 = \beta^2 \tag{38}$$

Eliminating c_1 between (37) and (38), we have

$$(c_0+1)\alpha^2 - (a+1)\beta^2 = (a - c_0) \tag{39}$$

Introducing the linear transformations

$$\alpha = X + (a+1)T \ , \ \beta = X + (c_0+1)T \tag{40}$$

in (39) and simplifying we get

$$X^2 = (a+1)(c_0+1)T^2 - 1$$

which is satisfied by $T = 1$, $X = 5k+2$

In view of (40) and (37), it is seen that

$$c_1 = 5k^2 + 14k + 9$$

Let c_2 be any integer such that

$$(a+1)c_2 + a = \alpha^2 \tag{41}$$

$$(c_1+1)c_2 + c_0 = \beta^2 \tag{42}$$

Eliminating c_2 between (41) and (42), we have

$$(c_1+1)\alpha^2 - (a+1)\beta^2 = (a - c_1) \tag{43}$$

Introducing the linear transformations

$$\alpha = X + (a+1)T \ , \ \beta = X + (c_1+1)T \tag{44}$$

in (43) and simplifying we get

$$X^2 = (a+1)(c_1+1)T^2 - 1$$

which is satisfied by $T = 1$, $X = 5k+7$

In view of (44) and (41), it is seen that

$$c_2 = 5k^2 + 24k + 28$$

Let c_3 be any integer such that

$$(a+1)c_3 + a = \alpha^2 \tag{45}$$

$$(c_2+1)c_3 + c_0 = \beta^2 \tag{46}$$

Eliminating c_3 between (45) and (46), we have

$$(c_2+1)\alpha^2-(a+1)\beta^2=(a-c_2) \quad (47)$$

Introducing the linear transformations

$$\alpha=X+(a+1)T \ , \ \beta=X+(c_2+1)T \quad (48)$$

in (47) and simplifying we get

$$X^2=(a+1)(c_2+1)T^2-1$$

which is satisfied by $T=1$, $X=5k+12$

In view of (48) and (45), it is seen that

$$c_3=5k^2+34k+57$$

The repetition of the above process leads to the generation of sequence of 3-tuples whose general form is given by (a,c_{s-1},c_s) where

$$c_{s-1}=5k^2+(10s-6)k+(5s^2-6s+1) \ , \ s=1,2,3,...$$

A few numerical examples are presented in Table 4 below:

Table 4: Numerical Examples

k	(a,c_0,c_1)	(a,c_1,c_2)	(a,c_2,c_3)	(a,c_3,c_4)
2	(4,28,57)	(4, 57, 96)	(4, 96, 145)	(4, 145, 204)
3	(4,57,96)	(4, 96, 145)	(4, 145, 204)	(4, 204, 273)
4	(4,96,145)	(4, 145, 204)	(4, 204, 273)	(4, 273, 352)
5	(4,145,204)	(4, 204, 273)	(4, 273, 352)	(4, 352, 441)

Sequence 5:

Let $a=4, c_0=5k^2-4k$

It is observed that

$$ac_0+a+c_0=(5k-2)^2$$

Let c_1 be any integer such that

$$(a+1)c_1+a=\alpha^2 \quad (49)$$

$$(c_0+1)c_1+c_0=\beta^2 \quad (50)$$

Eliminating c_1 between (49) and (50), we have

$$(c_0+1)\alpha^2-(a+1)\beta^2=(a-c_0) \quad (51)$$

Introducing the linear transformations

$$\alpha=X+(a+1)T \ , \ \beta=X+(c_0+1)T \quad (52)$$

in (51) and simplifying we get

$$X^2=(a+1)(c_0+1)T^2-1$$

which is satisfied by $T=1$, $X=5k-2$

In view of (52) and (49), it is seen that

$$c_1=5k^2+6k+1$$

Let c_2 be any integer such that

$$(a+1)c_2+a=\alpha^2 \tag{53}$$

$$(c_1+1)c_2+c_0=\beta^2 \tag{54}$$

Eliminating c_2 between (53) and (54), we have

$$(c_1+1)\alpha^2-(a+1)\beta^2=(a-c_1) \tag{55}$$

Introducing the linear transformations

$$\alpha=X+(a+1)T \;,\; \beta=X+(c_1+1)T \tag{56}$$

in (55) and simplifying we get

$$X^2=(a+1)(c_1+1)T^2-1$$

which is satisfied by $T=1$, $X=5k+3$

In view of (56) and (53), it is seen that

$$c_2=5k^2+16k+12$$

Let c_3 be any integer such that

$$(a+1)c_3+a=\alpha^2 \tag{57}$$

$$(c_2+1)c_3+c_0=\beta^2 \tag{58}$$

Eliminating c_3 between (57) and (58), we have

$$(c_2+1)\alpha^2-(a+1)\beta^2=(a-c_2) \tag{59}$$

Introducing the linear transformations

$$\alpha=X+(a+1)T \;,\; \beta=X+(c_2+1)T \tag{60}$$

in (59) and simplifying we get

$$X^2=(a+1)(c_2+1)T^2-1$$

which is satisfied by $T=1$, $X=5k+8$

In view of (60) and (57), it is seen that

$$c_3=5k^2+26k+33$$

The repetition of the above process leads to the generation of sequence of 3-tuples whose general form is given by (a, c_{s-1}, c_s) where

$$c_{s-1}=5k^2+(10s-14)k+(5s^2-14s+9) \;,\; s=1,2,3,\ldots$$

A few numerical examples are presented in Table 5 below:

Table 5: Numerical Examples

k	(a,c_0,c_1)	(a,c_1,c_2)	(a,c_2,c_3)	(a,c_3,c_4)
2	(4,12,33)	(4, 33, 64)	(4, 64, 105)	(4, 105, 156)
3	(4,33,64)	(4, 64, 105)	(4, 105, 156)	(4, 156, 217)
4	(4,64,105)	(4, 105, 156)	(4, 156, 217)	(4, 217, 288)
5	(4,105,156)	(4, 156, 217)	(4, 217, 288)	(4, 288, 369)

Sequence 6:

Let $a=12, c_0=13k^2-10k+1$

It is observed that

$ac_0+a+c_0=(13k-5)^2$

Let c_1 be any integer such that

$$(a+1)c_1+a=\alpha^2 \quad (61)$$

$$(c_0+1)c_1+c_0=\beta^2 \quad (62)$$

Eliminating c_1 between (61) and (62), we have

$$(c_0+1)\alpha^2-(a+1)\beta^2=(a-c_0) \quad (63)$$

Introducing the linear transformations

$$\alpha=X+(a+1)T \;,\; \beta=X+(c_0+1)T \quad (64)$$

in (63) and simplifying we get

$$X^2=(a+1)(c_0+1)T^2-1$$

which is satisfied by $T=1$, $X=13k-5$

In view of (64) and (61), it is seen that

$$c_1=13k^2+16k+4$$

Let c_2 be any integer such that

$$(a+1)c_2+a=\alpha^2 \quad (65)$$

$$(c_1+1)c_2+c_0=\beta^2 \quad (66)$$

Eliminating c_2 between (65) and (66), we have

$$(c_1+1)\alpha^2-(a+1)\beta^2=(a-c_1) \quad (67)$$

Introducing the linear transformations

$$\alpha=X+(a+1)T \;,\; \beta=X+(c_1+1)T \quad (68)$$

in (67) and simplifying we get

$$X^2=(a+1)(c_1+1)T^2-1$$

which is satisfied by $T=1$, $X=13k+8$

In view of (68) and (65), it is seen that

$$c_2 = 13k^2 + 42k + 33$$

Let c_3 be any integer such that

$$(a+1)c_3 + a = \alpha^2 \tag{69}$$

$$(c_2+1)c_3 + c_0 = \beta^2 \tag{70}$$

Eliminating c_3 between (69) and (70), we have

$$(c_2+1)\alpha^2 - (a+1)\beta^2 = (a - c_2) \tag{71}$$

Introducing the linear transformations

$$\alpha = X + (a+1)T \;,\; \beta = X + (c_2+1)T \tag{72}$$

in (71) and simplifying we get

$$X^2 = (a+1)(c_2+1)T^2 - 1$$

which is satisfied by $T = 1$, $X = 13k + 21$

In view of (72) and (69), it is seen that

$$c_3 = 13k^2 + 68k + 88$$

The repetition of the above process leads to the generation of sequence of 3-tuples whose general form is given by (a, c_{s-1}, c_s) where

$$c_{s-1} = 13k^2 + (26s - 36)k + (13s^2 - 36s + 24) \;,\; s = 1, 2, 3, \ldots$$

A few numerical examples are presented in Table 6 below:

Table 6: Numerical Examples

k	(a, c_0, c_1)	(a, c_1, c_2)	(a, c_2, c_3)	(a, c_3, c_4)
2	(12,33,88)	(12, 88, 169)	(12, 169, 276)	(12, 276, 409)
3	(12,88,169)	(12, 169,276)	(12, 276, 409)	(12, 409, 568)
4	(12,169,276)	(12, 276,409)	(12, 409, 568)	(12, 568, 753)
5	(12,276,409)	(12,409,568)	(12, 568,753)	(12, 753, 964)

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Scientometric Portrait of Prof. Muthukalingan Krishnan: A Molecular Biologist

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Abstract: This study analyzes the major aspects of the career of the Indian Scientist, Prof. Muthukalingan Krishnan. This paper analyzes the publication productivity of Professor Dr.Muthukalingan Krishnan, Vice Chancellor of Madurai Kamaraj University, Madurai, and Tamilnadu, India. The data collected from Google Scholar Profile by using Pop (Publish or Perish) software. The study finding indicates that Prof. Muthukalingan Krishnan has produced 197 scholarly publications with 181 journal articles. He has produced an average of five publications each year almost all 90.2% of his publication were multiple authored and he has collaborated with 764 researchers Prof. Muthukalingan Krishnan's scientific articles are published in 47 different Journals; filtering the Lotka's Law of scattering. His publications have received 1219 citations and since 2014 he has 904 citations and an H index of 16, I10 index of 28. These findings suggest, among other things, that his research efforts have concentrated largely on molecular biology and nanotechnology. He is eminently qualified to be taken as a role model for the younger generation to emulate. He is undoubtedly one of the most outstanding scientists in India.

Keywords: Scientometric analysis, Prof. Muthukalingan Krishnan, Citation, Google Scholar, Publish or Perish

I. Introduction

Professor Dr.Muthukalingan Krishnan, Vice-Chancellor of Madurai Kamaraj University, Madurai. He has 28 years' teaching experience and served as the head of the department in Bharathidasan University, Trichy, followed by a tenure as professor of the Central University in Ajmer, Rajasthan. He has been a fellow of Royal Entomological Society, London, Society for Science and Environment, India, Commonwealth Fellow, UK and Japan Prize Foundation. Professor Dr. Muthukalingan Krishnan was a visiting professor at various University like Okayama University of Science, Czech Academy of Science, Institute of biomedicine, Helsinki, and University of exciter and university of Edinburgh, Scotland. He has 181 articles and two books in molecular biology
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The term Scientometricsrecognition by the foundation in 1978 of the journal Scientometrics by Tibor Braun in Hungary and currently from Amsterdam. According to its subtitle, Scientometrics includes all quantitative aspects of science, communication in science, and science policy (Wilson, 2001). Bio-bibliometrics is a term that was first coined by Sen and Gan (1990) to mean the quantitative and analytical method for discovering and establishing functional relationships between bio data and biblio-data elements. Bio-bibliometric is a study in which we statistically analyze publications of an individual, a department, or a subject of any field. It is a quantitative and analytical method in which we try to establish a functional relation between bio-data of an individual and his biblio-data. Mathematical and statistical techniques are used to study a publication's pattern, preferences, author's collaboration and chronological distribution of publications (Qayyum&Naseer, 2013). The present study centers on the contributions Jeffrey C. Hall, an American scientist, who won the Nobel Prize 2017 for Medicine for their discoveries of "molecular mechanisms controlling the circadian rhythms.

Objectives

- Toidentify the year-wise distribution of authorship pattern

- To identify the Quinquennium Publications
- To identify the Authors and Co-Authors for Research Articles

II. Data Analysis

Growth of Analysis

The year wise publications of cumulative number of research article publications and authorship Table 1. 13 single authored articles published by Professor M.Krishnan, followed by 168 articles published by multi authors. The majority of the publicationspublished by M. Krishnan with collaboration of five authors (42). The CAPC varies with PPA in accordance with the equation: X=PPA and Y=CAPC.(Figure 1)

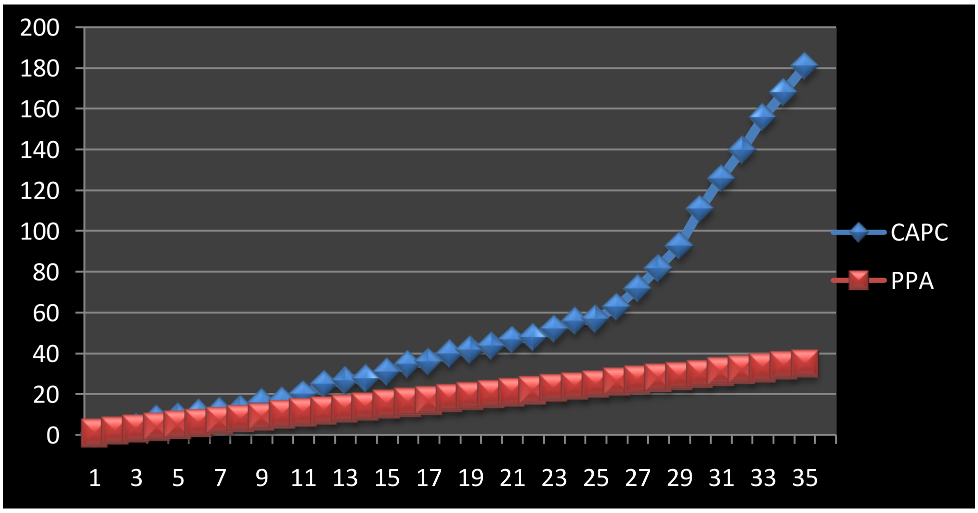

Figure 1: Difference of Cumulative Annual Publication Count with Publications Productivity

Table 1 M. Krishnan Growth of Research Articles and Authorship Pattern

YEAR	APC	CAPC	PPA	SAP	MAP	1ST	2ND	3RD	<3 Authors	no.of authors	DC=MAP/APC
1960	1	1	1	1		1					0
1981	1	2	2		2		2				2
1982	2	4	3	1	3	1		1			1.5
1984	4	8	4	1	3	1	3				0.75
1986	1	9	5	1		1					0
1987	2	11	6		2		1			1	1
1988	1	12	7		1		1				1
1989	1	13	8		1		1				1
1992	3	16	9	2	2	1		1		1	0.66
1993	1	17	10		1			1			1
1994	3	20	11	1	1	2				1	0.33
1995	5	25	12		5			3			1
1996	2	27	13		2			1		3	1
1997	1	28	14		1					1	1

1998	3	31	15	1	1	2		1			0.33
1999	4	35	16		4			2		2	1
2000	1	36	17		1			1			1
2002	4	40	18		2	2		1		1	0.5
2003	2	42	19	1	1	1	1	1			0.5
2004	2	44	20		2			1			1
2005	3	47	21		3				1	3	1
2006	1	48	22		1					1	1
2007	4	52	23		4			2		2	1
2008	4	56	24		4			2		2	1
2009	1	57	25		1			1			1
2010	6	63	26	1	5	1		4		1	0.833
2011	9	72	27		9			1		6	1
2012	10	82	28		10	2		2		6	1
2013	11	93	29		11		1	2		8	1
2014	18	111	30	2	16	2	2	4		10	0.88
2015	15	126	31	1	14	1		2		12	0.93
2016	14	140	32		14			1		13	1
2017	16	156	33		16		1			15	1
2018	12	168	34		12		1			11	1
2019	13	181	35		13					13	1
	181			**13**	**168**	**18**	**14**	**35**	**1**	**113**	

[APC=Annual Publication Count; CAPC=Cumulative Annual Publication Count; AA=Author's Age; =Publication productivity Age; DC=Degree of Collaboration; MAP=Multi-Authored Publications; SAP=Single-Authored Publications]

The Quinquennium publications of Professor. M. Krishnan is presented in Table 2. The highest publication (70) was during the year 2015 to 2019 followed by 54 contributions during 2010 to 2004 and every 13 contributions during the year 1994 to 2009. The author was thus most active from 1999 to 2019. He was potentially active during 2015- 2019. The contribution of Professor. M. Krishnan was least during the year 1960 to 1993 with 17 publications.

Table 2 Quinquennium Publications

YEAR	PPA	APC
1960-1986	1-5	9
1987-1993	6-10	8
1994-1998	11-15	14
1999-2004	16-20	13
2005-2009	21-25	13
2010-2014	26-30	54
2015-2019	31-35	70

Authorship Analysis

The quantity of the first authors and the co-author's list in Table 3. The ranked list of the co-authors is enumerated in Table 4. S. Anbalagan is the top-ranked co-author of Professor. M. Krishnan (co-authored 37 papers in 15 years) followed by S.Dinakaran with 17 papers in 10 years followed by Kannan and S.Janarthan who co-authored 10 papers each over 8 years. The sixth and seventh-ranked co-authors are Nirmala and S.Chokalingam who contributed each7 papers respectively for 7 years each. .

Table 3 List of First Authors and Co-Authors for Research Articles since 1960 to 2019

ear	1st Authors' Names	Co-Authors' Names
960		
981 982	K Ramalingam, MKS chockalingam	RN Gargesh
984	S Chockalingam,	S Chockalingam,
986	MKS Chockalingam	
987	Sahayaraj,	S Chockalingam, K S Kumara Sankaralinkam, R Balasubramanian
988		S Chockalingam
989		S Chockalingam
992	KM Subburathinam, C Balachandran	S Janarathanan,SAnbalagan,SDinakaran,KSuberkropp, ..
993	KM SubbuRathinam,	J SulochanaChetty
994	S Janarthanan,	MSathiamoorthi,KMSRathinam,S.Janarthanan, K. M. SubbuRathinam
995	SK Pandian, S Janarthanan, S Anbalagan,	KM Subburathinam, S Janarthanan S Kuma KDharmalingam,CDamodaran, D Livingstone, KMS Rathinam Arunprasanna, M Kannan, S Dinakaran,
996	R Sankaranarayanan, V Vanisree,	BMathew,PPNair, T Somanathan, C Varghese, X Nirmala
997	A Jayadeep,	KP Raveendran, S Kannan, KR Nalinakumari, B Mathew
998	S Janarthanan, VVMK X. Nirmala	K.M. Subburathinam S Ignacimuthu
999	Z Dziong, X Nirmala, V Vanishree, S Janarthanan,	S Kumar, S Nanda V Vanishree, X Nirmala, S Sankar, S Ignacimuthu
000	VS Kumar,	M Santhi
002	X Nirmala, UBMK G.Ravikumar JB Jasmine, ARMK A	VVanishree,ARajathi,MChitra,Babila Jasmine
003	L IsaiarasuVVMK X. Nirmala	S Mathavan
004		S. Janarthanan, Suresh. P
005	APKKP.RChandrasekar,VVanishreVArunprasanna,	Somasundaram.K.Thangavelu,R.KRDhanalakshmi, HJ Kim, H Jeong, X Nirmala, E Arul, M Kannan, S Anbalagan, J Krieger
006	S Anbalagan,	S Dinakaran,SAnbalagan,
007	CRaman,RChandrasekar, S Kannan, PM Meenakshi,	SL Manohar, N Xavier, SL Manohar TK Taneja, SV Kumar Chandrasekhar,
008	RChandrasekar,STKrishnanSKannan,	SS Jae, P Sumithra, SS Jae, M, Muthumeenakshi P, Bharathiraja Warrier S
009	P Sumithra,	R Chandrasekar,
010	P.Sumithra,S.Saini,A.Rajathi,J.S.Anbalagan, R Chandrasekar	CP Britto, J McGlohorn, Q Liu,JYoo, TG West, Pandiarajan, Dinakaran, S Konig, SL Manohar,
011	JJAntony,JPandiarajan,SAnbalagan, RVivek,RSukirtha, S Kannan, EMM Ali, B Chinnapandi,	P.Sivalingam,D.Siva,S.Kamalakkannan,K.Anbarasu BP Cathrin, Pratheep, S Dinakaran, J Pandiaraja S.Kannan,S.Achiraman,R.Thirumurugan,DS.Ganesh,RRamachandra S Kamalakkannan, S,Pandiarajan.PMareeswaran,S N Spencer Ibrahim, RM Ashraf, E Tousson, L An, CT Liu, XB Qin, QH Liu, Raman, A Sinnakaruppan, M Sundaram,
012	R.Sukirtha,BC.Pakkianathan,P.Revathi,	KM.Priyanka,JJ.Antony,S.Kamalakkannan,R.Thangam N Singh,SKönig P Iyapparaj, N Munuswamy,
013	SD, MKS Beryl VedhaYesudhason VA Prasanna, NK Singh, P Dev, UM Hohenester, MKSK	S.Anbalagan and JothipandiJ.Pandiaraja,BC.Pakkkianathan, Kumar, JR Daddam, S Jayavel, VK Ramappa, R Gopal, Wattanathorn, S Muchimapura, A Boosel, AM Mehlich, NK Singh, Krishnan, S KönigUlli-Martin Hohenester, Anna-Maria Mehlich, Nitin

014	C.Bharathiraja,S.Anbalagan,P.Revathi, R.Peranandam,PNB.Munuswam.KBalakrishnan, J.Pandiarajan,VA.Prasanna,CKKN.Neelamegam,	J Pandiarajan, VA Prasanna, J Rajendhran,PIyapparaj, LA Vasanthi, Munuswamy, I Palanisamy, AV Lourdaraj, M NatesanIyapparaj, L Vasanthi, S,Arunprasanna. V,Ponraman. G,Balachandra C,Dinakaran.S V Murali, C Rathika, T Manikandan, RP Malini Suganya, , N Kayalvizhi, N Rameshkumar, S Dinakaran M Kannan , Sukirtha, S Achiraman Y Heifetz, S Achiraman,
015	M Periasamy, BC Pakkianathan, S Anbalagan, A Petrovic, V Arunprassana A Sankarappan, J Pandiarajan, , NP Reneeta	R Schafleitner,SRamasamy V Sivanandham, D Hans-Uwe, S Murugaiah, P Seeni NK Singh, S König V Arunprasanna, M Kannan, Dinakaran D Milosevic, M Paunovic, S Simic, N Dordevic, M Stojkov C Balachandran, B Chellapandian, AP Vimalanathan, K Mani Suganya, ,S Achiraman, P Sundararaju
016	RK Govindarajan, M Kannan, J Pandiarajan, C Balachandran, SK Kim, J Suriya, S Dhanam, N Rameshkumar, V Arunprasanna	S Revathi, N Rameshkumar,NKayalvizhi V Suryaathmanathan, Saravanakumar, A Jaleel S Balaji, S Mahendran, P Ponmanickam Anbalagan, M Kannan, S Dinakaran F Toldrá, AR Uria, DS Zilda, Das, D Roy, R Sen, V Venugopal, R Seemaisamy, R Neelamegam, Bharathiraja,PManivasagan, SK Kim T Suganya, J Pandiarajan Arumugam, RK Govindarajan, ,
017	S.Bharathiraja,J.Suriya,J.Pandiarajan,R.Pervin, S.Anbalagan,MKannan S Dinakaran, S Revathi, KG.Rasiravuthanahalli,T.Pratheep,TKubendran,NRameshkumar,	J Suriya,PManivasagan, SK Kim MC Shekar, NM Nathani, T Sugany S Bharathiraja HU Dahms, P Seeni, S Gopalan, V Sivanandham, Rana, M Kannan, S Arumugam, PM Shirage S Dinakaran R Govindarajan, N Rameshkumar, FL Hakkim R Neelamegam, Nagaraj T Ramya S Thangaiyan N Kayalvizhi NK Singh, P Britocathri S Shantkriti, B PadmanabanS Chellappa,A Nair
018	RK.Pandey,R.Pervin,SAnbalagan, J PandiarajanA.Sankarappan,P.Thangaraj,S.Revathi,VS.Aathmanathan, J.Suriya,DK.Thiyagarajamoorthy,NP.Reneeta,B.Thiyonila,	R Ojha, VS Aathmanathan, VK Prajapati AK Rana, S Arumugam, P Shirage S Vijayan, C Balachandran, S Dinakaran K Mani, Sundaram, B Chelliah R kumarNeelamegam, K Nagarajan FL Hakki NR Kumar, HA Bakshi, L Rashan, M Al-Buloshi N Jothi, VK Prajapa S Bharathiraja, V Sekar, V Sachithanandam CD Arulanandam, H Dahms, SG Murugaiah , B Thiyonila, T Ramya, P Chandrasekar, N Reneeta,SShantkriti
019	N Khatoon, RK Govindarajan, Shyu T Arumugam, C Anbalagan, R Pervin, S Cheemadan, P Malini, EM Abhinav, S Vijayan, K Rekha, M Kannan, S Jayaraman,	RK Pandey, R Ojha, VS Aathmanathan, R Neelamegam, DJH Dhanam, N Rameshkumar,NKayalvizh S Vijayan, S Dinakaran, Ishigaki, J Gouchi, R Pervin, GK Selvan A Sonachalam, PM Shira AJ Rathinam, MCS Kumar S Ramasamy, R Schafleitner A Sundarar D Jaison, G Chandrasekaran S Anbalagan, K Rekha D Mubarakali, Thiyonila, B Padmanaban S Thangaiyan, K Mani, K Nagarajan

Table 4: Position of Co Authors

Rank	No.of papers contributed with M.Krishnan	Co AuthorsName	No.of Contributing years	P/Y
1	32	S.Anbalagan	15	2.13
2	17	S.Dinakaran	10	1.7
3	10	Kannan	8	1.25
4	8	S. Janarthanan	8	1
5	8	Prasanna	6	1.3
6	7	Nirmala	4	1.7
7	7	S.Chokalingam	7	1.7
8	5	Arul,C.Raman, J.Antony,S.kumar, Subburathinam,Chandrasekar,Bakiyaraj	Each 5 papers	5
9	1	R Ojha, VS athmanathan, VK Prajapati AK Rana, S Arumugam, PM Shirage S Vijayan, C Balachandran, K Mani, D Sundaram, B Chelliah R kumarNeelamegam, K Nagarajan FL Hakkim, NR Kumar, HA Bakshi, L Rashan, M Al-Buloshi N Jothi, VK Prajapati S Bharathiraja, V Sekar, V Sachithanandam CD Arulanandam, HU Dahms, SG Murugaiah , B Thiyonila, T Ramya, NP Reneeta,SShantkriti RK Pandey, R Ojha, VS Aathmanathan, R Neelamegam, DJH S Dhanam, N Rameshkumar,NKayalvizh S	Each 1papers	1

		Vijayan, S Dinakaran, K Ishigaki, J Gouchi, R Pervin, GK Selvan A Sonachalam, PM Shirage AJ Rathinam, MCS Kumar S Ramasamy, R Schafleitner A Sundararaj, D Jaison, G Chandrasekaran K Rekha D Mubarakali, B Thiyonila, B Padmanaban S Thangaiyan, K Mani, K Nagarajan		

Co-authorship and Lotka's Law

According to Lotka's law of scientific productivity, fifteen percent of the authors in a field will produce more than 30 articles. Lotka's law, when applied to large bodies of literature over a fairly long period of time, can be accurate in general, but not statistically exact. The general form of Lotka's law can be expressed as y=c/xn where y=percentage of authors, x=number of articles published by an author, c=constant and –n=slope of the log-log plot. In this co-authorship analysis, there are 61 co-authors of Professor Krishnan, of which 39 co-authors (63%) were associated with a single article, 3 coauthors were (5%), were associated with two articles, 5 co-authors were (8.2%) were associated with three articles and so on. The co-authorship data thus nearly tallies Lotka's Law. The Lotka's equation for this co-authorship data is found as Y=45/(X) 0.9, where Y = Cumulative no. of co-authors and X = Cumulative no. of articles

CONCLUSION

This study highlights the major aspects of the career of Biological scientist Prof. Muthukalingan Krishnan. Similar studies on prominent scientometrics include Eugene Garfield, Tibor Braun, Mike Thelwall and K C.Pitchumani; have been obvious in the literature. The scholar, Prof. Muthukalingan Krishnan is the second Indian figure to be considered for a bibliometric study besides KC. Pitchumani. He contributed 181 writings since 1960 to 2019, i.e. during 59 years of his service period plus retirement period. Of the 181 writings, he contributed about three research articles per year consistently over the entire career period. His academic and research activity steadily increased with his age. His most notable research works were normalization of Impact Factor and finding Impact Factor of SCI journal. He is still academically very active and continues adding research contributions. Biobibliometric studies help to analyze profiles of individual scientists over the years that enable identification of the knowledge generation and development cycle at different phases. Also, consolidated studies of numbers of individual contemporaries and individuals of different eras are necessary to find out an impact analysis of a subject at times.

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