WATTS 2019-01

Year 89 + 01m

Monthly Newsletter of the Pretoria Amateur Radio Club
Maandelikse Nuusbrief van die Pretoria Amateur Radio Klub

PARC, PO Box 73696, Lynnwood Ridge 0040, RSA
http://www.parc.org.za zs6pta@zs6pta.org.za

Bulletins : 145.725 MHz : Sundays from 08h45 / Sondae vanaf 08h45
Relays: 1.840, 3.700, 7.066, 10.135, 14.235, 51.400, 438.825, 1297 MHz and Echolink. Activated frequencies are announced prior to bulletins
Swopshop : 2m and 7.066 MHz live on-air after bulletins
Bulletin repeats on Mondays / herhalings op Maandae : 2m 19h45

Pretoria Amateur Radio Klub se aktiwiteite het vroeg afgeskop met 'n snuffelmark op die 6de Januarie 2019, wat goed bygewoon is. Tussen deur die verkope is daar ook lekker informeel saamgekuier. Op Watts se voorblad Pieter Myburgh ZS6PAM, Fritz Sutherland ZS6SF, Johan de Bruyn ZS6JHB, Irene Myburgh ZS6IEA en haar kleindogter, en Corrie Visser. Meer op bladsye 3 en 5.

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Club Meetings / Klub Vergaderings

Club Committee Meeting :

The next Committee Meeting will be on Wednesday, the 16th of January 2019 from 18h30 at Pretoria Old Motor Club.

PARC Committee Members : 2018 – 2019 / PARK Komiteelede : 2018 - 2019

Name & Callsign	Portfolio/s	Email Adress	Tel No	Mobile No
Louis de Wet ZS6SK	Chairman, Watts, Club History	louis.zs6sk@gmail.com	012-349-1044	072-140-9893
Graham Reid ZS6GJR	Vice Chairman, Treasurer, Website	greid@wol.co.za	012-667-2720	083-701-0511
Etienne Naude ZS6EFN	SARL Liaison, Bulletin Coordinator	etienne@afrigrid.com	012-661-6745	082-553-0542
Irene Myburgh ZS6IEA	Club Secretary	Irene@srsa.gov.za	012-304-5109	082-462-6001
Johan de Bruyn ZS6JHB	Rallies, Repeaters & Membership	zs6jhb@gmail.com	012-803-9418	079-333-4107
John Minter ZS6LED	Technical & RAE Training	john.minter.za@gmail.com	012-349-0019	083-291-5422

PARC Co-opted Members : 2018 – 2019 / PARK Ge-köopteerde Lede : 2018 - 2019

Name & Callsign	Portfolio/s	Email Adress	Tel No	Mobile No
Alméro Du Pisani ZS6LDP	Flea-markets	almero.dupisani@up.ac.za	012-420-3779	083-938-8955
Tony Crowder ZS6CRO	Auditor	tcrowder@telkomsa.net	011-672-3311	
Nic Louw ZS6NWL	Youth Development	nic.louw@telkomsa.net		083-596-1026
Whitey Joubert ZS6JJJ	Social & Competitions	zs6jjj@gmail.com	012-993-2267	072-120-4516
Pierre Holtzhausen ZS6PJH	Competitions	zs6pjh@gmail.com		082-575-5799
Pieter Myburgh ZS6PAM	Repeaters	wooden@mweb.co.za		076-140-7562

Birthdays and Anniversaries / Verjaarsdae en Huweliks Herdenkings

Member's Birthdays January 2019 / Lede Verjaarsdae – Januarie 2019

05 Pierre Holtzhausen ZS6PJH
07 Bertus Viljoen ZS6VIL
10 Wynand Wessels ZR6WW
21 Albert Schreuder ZS6SE

Spouse's January 2019 / Gades Januarie 2018

15 Moira, gade van Fanus Ferreira ZS6BUH
18 Zelda, gade van Wynand Wessels ZR6WW
25 Magriet, gade van Tobie Jansen van Rensburg ZS6ZX

Anniversaries January / Herdenkings – Januarie

05 Louise en Louis (Alméro) Du Pisani ZS6LDP
11 Judy and David Basil Botha ZS6O
20 Helga en Hans-Peter Knoepfler ZS6AJS

Member's Birthdays February 2019 / Lede Verjaarsdae – Februarie 2019

02 John Minter ZS6LED
03 Willie Greyling ZR6WGR
03 Nico van Tonder (Erelid) ZS6AQ
04 James Bestbier ZS1XN
04 Louis de Wet ZS6SK
09 Kenny Martin ZS6KMM
16 de Jager Burger ZS6ZO
23 Pete Smith-Curren ZS6PJ
28 Basie du Plessis ZR2BA

Spouse's December 2018 / Gades Desember 2018

10 Paddy, gade van Kenny Martin ZS6KMM
23 Erika, gade van Pine Pienaar ZS6OB

Anniversaries December / Herdenkings – Desember

03 Heather and Vincent Harrison ZS6BTY
07 Juanita en Ryan Gibson ZS6GGR
16 Dienkie en Pierre Britz ZR6ADZ
27 Paddy en Kenny Martin ZS6KMM
27 Zelda en Wynand Wessels ZR6WW
28 Martie en Jurgen de Beer (Erelid) ZR6YV

Lief en Leed /Joys and Sorrows

It is with great sadness that we have learned of the passing of Maggie, the spouse of John Ogden ZR6JAO. Our sincere condolences from the PARC Committee and Members.

Jacobus (JJ) Snyders ZS6JSJ het onlangs 'n hartomleiding operasie ondergaan. Die operasie was 'n sukses en JJ sterk goed aan. PARC wens hom alle sterkte toe.

Pieter Fourie ZS6CN het terwyl hy by die werk aan 'n apparaat gewerk het, 'n lang sny aan een van sy vingers gekry. Ons wens Pieter spoedige herstel en beterskap toe.

PARC Membership Fees / PARK Ledegelde

During the 2018 AGM, the decision was made that Club Fees would not be increased for the financial year. Club Fees therefore remain at R160 for Ordinary Members, and R60 for Pensioners and Spouse. Gedurende die 2018 AJV, die besluit is geneem dat Klub Ledegelde nie verhoog sal word nie. Dus bly die gelde op R160 vir Gewone Lede, en R60 vir Pensionarisse en Gade.

PARC SUBS : PARK LEDEGELD : FROM / VANAF : 30-06-2018			
Bank	First National Bank	Ordinary Members / Gewone Lede : R160 Spouses / Pensioners : R60	**Your call sign must appear as statement text!**
Branch Code	25 20 45		
Account No	546 000 426 73		
Please remit your subs in time to our Treasurer, or pay per transfer into the PARC account Betaal asb. u ledegelde betyds aan ons Tesourier, of betaal per oorplasing in die PARC rekening			

Please Note : If your Club fees are not paid up to date, birthday details cannot be displayed in Watts

PARC Bulletin Roster / PARK Bulletin Rooster

PARC Bulletins are presented on Sunday mornings at approximately 08h45, after the SARL Bulletins in English and Afrikaans, from 08h15. The Bulletin Presenters for the following two months are presented below. Please do contact the applicable presenter beforehand if you wish to make a contribution to the Bulletin. PARC Bulletins are broadcast on the 2 meter repeater on 145.725 MHz, and 70 cm on 438.025 MHz. Relays are done on 7.060 MHz by Hans Kappetijn ZS6KR and on Echolink by Johan Lehman ZS6JPL. A re-broadcast of the Bulletin is done the following Monday evening at 19h45 by Hans ZS6KR.

PARK Bulletins word op Sondag oggende aangebied om 08h45, na die SARL Bulletins in Engels en Afrikaans, vanaf 08h15. The Bulletin aanbieders vir die volgende twee maande word onder aangedui. Kontak gerus die toepaslike Bulletin leser indien u 'n bydrae tot die Bulletin wil maak. PARK Bulletins word uitgesaai op die 2 meter Herhaler op 145.725 MHz, en 70cm op 438.205 MHz. Herleidings word gedoen op 7.060 MHz deur Hans Kappetijn ZS6KR, en op Echolink deur Johan Lehman ZS6JPL. 'n Heruitsending van die Bulletin geskied die opvolgende Maandag aand om 19h45 wat behartig word deur Hans ZS6KR.

PARC Bulletin Presenters : January – April 2019			
Date	**Presenter**	**Date**	**Presenter**
20 January 2019	Johan de Bruyn ZS6JHB	24 March 2019	Louis de Wet ZS6SK
27 January 2019	Louis de Wet ZS6SK	31 March 2019	Etienne Naude ZS6EFN
3 February 2019	Etienne Naude ZS6EFN	7 April 2019	Alméro Du Pisani ZS6LDP
10 February 2019	Alméro Du Pisani ZS6LDP	14 April 2019	Johan de Bruyn ZS6JHB
17 February 2019	Johan de Bruyn ZS6JHB	21 April 2019	Louis de Wet ZS6SK
24 February 2019	Louis de Wet ZS6SK	28 April 2019	Etienne Naude ZS6EFN
3 March 2019	Etienne Naude ZS6EFN	5 May 2019	Alméro Du Pisani ZS6LDP
10 March 2019	Alméro Du Pisani ZS6LDP	12 May 2019	Johan de Bruyn ZS6JHB
17 March 2019	Johan de Bruyn ZS6JHB	19 May 2019	Louis de Wet ZS6SK

PARC Fleamarket Dates 2019 / PARK Snuffelmark Datums 2019

The following dates are set for PARC Flea Markets in 2019:
The volgende datums is vasgestel vir PARK Snuffelmarkte in 2019:

5 January / 5 Januarie ; 6 April ; 3 August / 3 Augustus ; 2 November

To book a table, please do contact: / Om 'n tafel te bespreek, kontak gerus:
Alméro Du Pisani ZS6LDP at 083-938-8955 or almero.dupisani@up.ac.za

Diary of Contests & Events / Dagboek van Kompetisies en Gebeure

Contests and Events – January 2019 / Kompetisies en Gebeure – Januarie 2019 (UTC Times)	
01	**Start of the 2019 CQ DX Marathon**
05	RSGB AFS Contest, CW: 13h00Z – 17h00Z
12 - 13	North American QSO Party, CW: 18h00Z – 05h59Z
13	NRAU-Baltic Contest, SSB: 05h30Z -07h30Z
13	NRAU-Baltic Contest, CW: 08h00Z – 10h00Z
13	DARC 10-Meter Contest: 09h00Z – 10h59Z
13	RSGB AFS Contest, SSB: 13h00Z – 17h00Z
13 - 16	Classic Exchange, CW: 13 – 14: 13h00Z – 07h00Z ; 15 – 16: 13h00Z – 07h00Z
19 - 20	Hungarian DX Contest: 12h00Z – 11h59
19 - 20	North American QSO Party, SSN: 18h00Z – 05h59Z
25 - 27	CQ 160-Meter Contest, CW: 22h00Z – 22h00Z
26 - 27	UBA DX Contest, SSB: 13h00Z – 13h00Z
Contests and Events – February 2019 / Kompetisies en Gebeure – Februarie 2019 (UTC Times)	
2 - 3	10-10 International Winter Contest, SSB : 00h01Z – 23h59Z
3	North American Sprint : 00h00Z – 04h00Z
4	RSGB 80m Club Championship : 20h00Z – 21h30Z
9	RSGB 1st 1.8MHz Contest: 12h00Z – 12h00Z
9 - 10	CQ WW RTTY WPX Contest : 00h00Z – 23h59Z
9 - 10	**SARL Field Day Contest : 10h00Z – 10h00Z**
9 - 10	Dutch PACC Contest : 12h00Z – 12h00Z
13	UNESCO World Radio Day
16	SARL Youth Day Sprint: 08h00Z – 10h00Z
16 - 17	ARRL International DX Contest, CW: 00h00Z – 24h00Z
22 - 24	CQ 160m Contest, SSB: 22h00Z – 22h00Z
23 - 24	REF Contest, SSB: 06h00Z – 18h00Z
23 - 24	UBA DX Contest, CW: 13h00Z – 13h00Z
24	SARL Digital Contest: 14h00 – 17h00
28	RSGB 80m Club Championship, CW: 20h00Z – 21h30Z

More information can be obtained from the SARL website, as well as the WA7BNM contest calendar at the following website: http://hornucopia.com

PARC Participation in Local Contests for 2019

The Pretoria Amateur Radio Club intends getting back with full force into the contest game during 2019. Under the leadership of Pierre Holtzhausen ZS6PJH, PARC is going to participate in all the South African Radio League contests hosted in 2019. Details of local contests are listed below:

South African Radio League QRP Contests:
Summer: 26 January 2019: 12:00 to 15:00 UTC
Autumn: 20 April 2019: 12:00 to 15:00 UTC
Winter: 20 July 2019: 12:00 to 15:00 UTC
Spring: 12 October 2019: 12:00 to 15:00 UTC

South African Radio League National Field Days:
Summer: 10:00 UTC on Saturday 9 February to 10:00 UTC on Sunday 10 February 2019
Spring: 10:00 UTC on Saturday 14 September to 10:00 UTC on Sunday 15 September 2019

South African Radio League HF Phone, Digital & CW Contests from home:
SSB: 14:00 to 17:00 UTC on Sunday, 4 August 2019
Digital: 14:00 to 17:00 UTC on Sunday 18 August 2019
CW: 14:00 to 17:00 on Sunday 25 August 2019

PARK Snuffelmark : 6 Januarie 2019

Die PARK snuffelmark aktiwiteite het vroeg die jaar afgeskop op die 6de Januarie by die gebruiklike Pretoria ou Motorklub. Dit was baie aangenaam om waar te neem dat daar baie besoekers was gedurende die dag, veral in die lig dat dit so vroeg in die jaar plaasgevind het. Daar was ook talle besoekers van ander klubs wat goedere verkoop het, of kom rondsnuffel het vir ‘n winskopie. Danksy die uitstekende reëlings van Almero DuPisani ZS6LDP, wat bygestaan is deur Kenny Martin ZS6KMM en sy gade, Paddy, en Whitey Joubert ZS6JJJ, en sy gade Erna, wat heerlike worsbroodjies en sous verkoop het, was die geleentheid werklik ‘n groot sukses. Ons sien uit na ‘n heerlike jaar van snuffelmarkte. Verwys na die skedule onder op bladsy 3 vir meer inligting.

Tydren Nuus : Johan de Bruyn ZS6JHB


Met die 2019 tydren seisoen wat binnekort afskop, kan ons weer uitsien na ‘n besige program. Die Tydren Kalender is voorsien deur Johan de Bruyn, wat tydren aktiwiteite koordineer. Indien u belangstel om deel te wees van tydren radio-diens, kontak gerus vir Johan by 079-333-4107 of zs6jhb@gmail.com. Die voorlopige datums van die Nasionale- en Streekstydrenne word onder aangedui.

With the 2019 rally season commencing soon, we can again look forward to a busy program. The Rally Calendar was provided by Johan de Bruyn, who is the coordinator of rally activities. If you are interested in becoming part of rally radio-service, feel free to contact to contact Johan at 079-333-4107 or zs6jhb@gmail.com. The preliminary dates of the National- and Regional rallies are presented below.

9 March 2019	Regional Event : to be announced
26 April 2019	York Rally Sabie
28 June 2019	PMC Rally
23 August 2019	To be announced
27 September 2019	Secunda Rally
25 October 2019	Electrothread Rally


SARL/AMSAT SA VHF/UHF WORKSHOP

The following letter was received from Dennis Green regarding a UHF/VHF workshop to be presented on the 9th of February 2019 at National Amateur Radio Centre. If you are interested to attend the Workshop, please RSVP to vhfnews@sarl.org.za by 7 February.

SOUTH AFRICAN RADIO LEAGUE

The National Body for Amateur Radio in South Africa
A Member of the International Amateur Radio Union

15 January 2019

To: Club Chairman
From: VHF/UHF Workshop organisers (vhfnews@sarl.org.za)

Dear Chairman,

THE SARL/AMSAT SA VHF/UHF WORKSHOP 9 FEBRUARY 2019

Frequencies above 30 MHz offer, for many amateurs, exciting new activities. The SARL and AMSAT SA are arranging a workshop at the National Amateur Radio Centre on Saturday 9 February from 09:00 – 14:00 and would like to invite you as our guest and inspire you (or a Club representative) to make VHF/UHF one of your club activities.

The programme is as follows:
09:00 Registration

09:30 Welcoming: Nico van Rensburg, ZS6QL, SARL President

09:30 Update on WRC-19 Agenda items that impact on VHF and UHF Amateur Radio spectrum - Hans van de Groenendaal, ZS6AKV
There are a number of agenda item at WR-C19 which take place towards the end of 2019 that could have an impact on Amateur Radio if they are agreed to as they currently stand. The Government Industry Preparatory Group met during January to consider South Africa's position.

09:45 The cost of a decibel on two metres - Dick Coates ZS6BUN

10:15 VHF and UHF propagation forecasting - Hans van de Groenendaal ZS6AKV
The various modes of VHF/UHF propagation will be discussed and methods that can be deployed to predict the likelihood of such conditions. If a long-distance VHF/UHF contact is made, what were the prevailing conditions and the use of this information in building a better forecasting system

11:00 Refreshment Break

11:30 Developing a reverse beacon network - Brian Jacobs ZS6YZ
The Reverse Beacon Network has evolved to become a powerful tool with many Amateur Radio applications, mostly on the HF bands. The RBN concept also provides unique opportunities for real time propagation awareness on VHF and UHF. In this presentation Brian looks how beacons and spot VHF/UHF calling frequencies can be monitored from different sites and generate alerts when an opening occurs. During his presentation he will demonstrate the concept with some practical examples

12:30 Update on currently operating beacons and a planned 2 m beacon mid-way between Gauteng and the Western Cape - Dick Coates ZS6BUN

National Amateur Radio Centre, Sender Technology Park, 1 Octave Street, Radiokop
PO Box/Posbus 1721, Strubensvallei, 1735, South Africa/Suid-Afrika
NARC/NARS Telephone/Telefoon: 011 675 2393 Facsimile/Faksimilee: 086 299 0566 E-mail/E-pos: admin@sarl.org.za
SARL Secretary/Sekretaris: secretary@sarl.org.za

13:00 Open discussion:

1. *Could multiple AMSATSA dual band Yagis be used to monitor beacons from various areas at the same time and provide a real time opening report?*
2. *How to get clubs more involved in promoting VHF/UHF activity*
3. *Will regular short burst competitions promote more activity*
4. *Setting up a Telegram early propagation alert system*

14:00 Ends

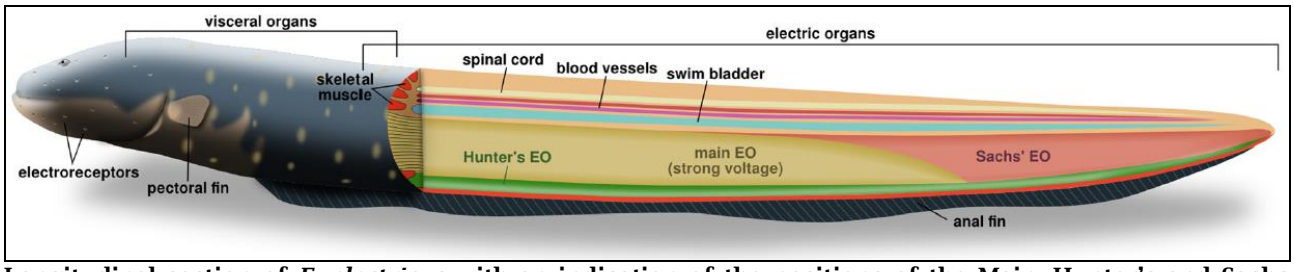
Please let us know if you or a Club representative will attend. RSVP to vhfnews@sarl.org.za by 7 February.

PS. Did you know that Amateur Radio Today has a weekly feature on VHF/UHF called "Focus on VHF and above". It is presented by Brian Jacobs, ZS6YZ. You can also download an audio file from the SARL web to play on your repeater as part of your weekly bulletin.

Electric Eels: Biological Capacitors

Should you be a little crab or fish swimming somewhere in the Amazon or Orinoco rivers in South America, this might be the last ugly face you will ever see. This face belongs to the Electric eel, *Electrophorus electricus* (Linnaeus, 1766), which is frequently found in muddy bottoms and calm waters of these rivers. But beware if you accidentally step on one of these creatures, or hook one with your fishing rod. You will definitely receive a jolting shock of up to 600 Volts at a current of 1 Ampere! If we look at the conventional ways of generating an electric current, whether Alternating or Direct Current, one cannot but curiously wonder how these fish are capable of generating these high voltages.

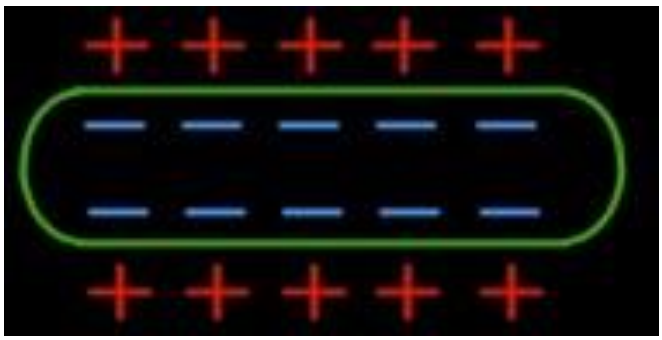
The electric eels belong to the Order Gymnotiformes, which are a group of teleost bony fishes commonly known as the Neotropical of South American knifefish. Within the Family Gymnotidae the banded knifefish and electric eels resort. But how is this remarkable amount of electric current generated in the tissue of these fish? One fifth of the volume of the eel's body consists of the head and the internal organs, while the remaining four fifths consist of the organs that generate electricity: the Main-, Hunter's- and Sachs organs. These organs enable the eel to generate both low- and high voltages. These organs consist of muscle-like cells or electrocytes, which are stacked in such a way that a current of ions flow through them and create a potential difference. One can think of it as these electrocytes connected in a series configuration, the same as battery cells connected in the same manner.



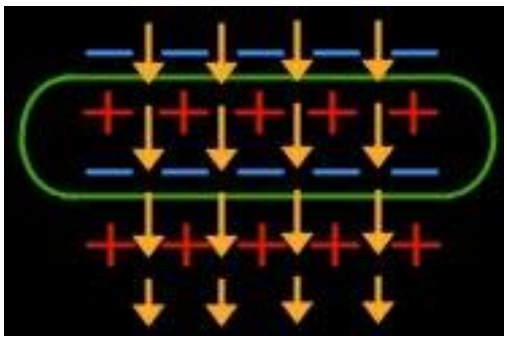
Longitudinal section of *E. electricus* with an indication of the positions of the Main, Hunter's and Sachs Electrical Organs. Ref: L.L. Traeger *et al* (2015)[1]

The Main- and Hunter's organs produce high voltage, which are used for self-defense, fright reflexes and the stunning of prey. The Sach's only produces low voltage pulses, and through electro-location the eel navigates and locates prey. Inside this organ, the electrocytes each produce 0.15V, with a cumulative total of 10V produced at a frequency of 25 Hertz.

In the Main- and Hunter's organs, approximately two hundred thousand of the disc shaped electrocytes can cumulatively produce an electric shock of up to 860 Volts at a current of 1 Ampere in a pulse lasting 2 milliseconds. In a sense, the mechanism of the voltage discharge in the electric eel is similar to that of a capacitor.



(1) Potential gradient across cell wall[2]

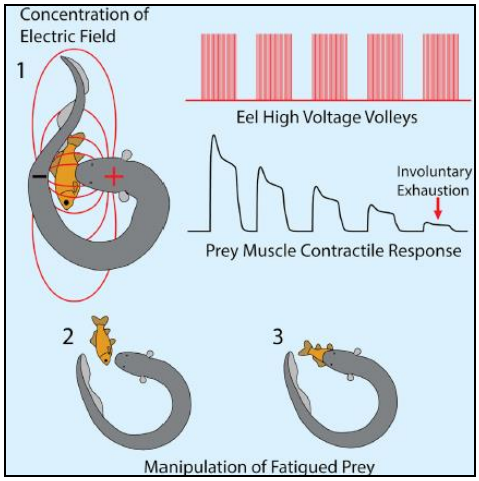


(2) Discharge of potential gradient[2]

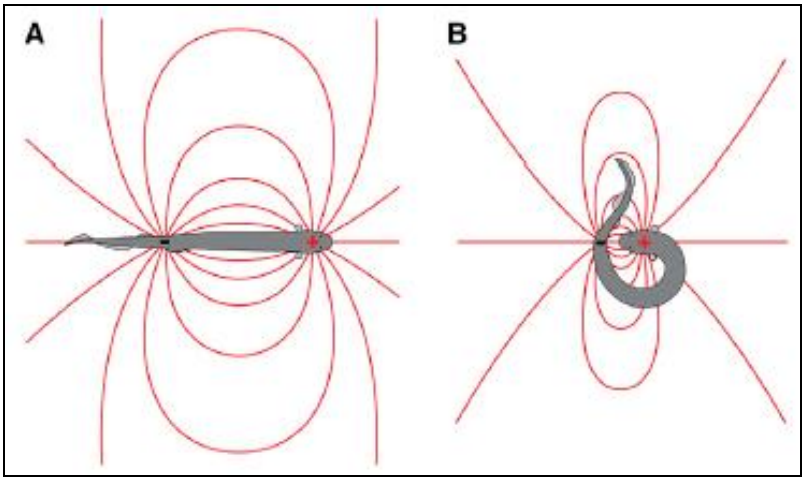
The specialized electrocytes, like all other living animal cells, maintain a potential gradient across the cell membrane (Figure 1). This is achieved by the active transport of sodium (Na^+) and potassium (K^+) ions through membrane pumps in the cell membranes. They are protein structures that span through the phospholipid double layers forming the cell membrane. Transport of these ions is coupled to the synthesis of ATP (Adenosine Triphosphate), which is the standard currency of energy in all biological organisms. At a resting state, the electrocytes have a net negative charge inside the cells (1), which is the result of a net efflux of Na^+ ions through the sodium potassium pumps. Although the intracellular concentration of K^+ is high, potassium ions flow from the cells under the influence of a concentration gradient (due to there being a higher concentration of K^+ in the cells). Subsequently, the extracellular positive charge now increases as the cytosolic (inside the cells) negative charge increases. Eventually the concentration gradient and the potential difference cancel each other out, and a state of equilibrium has developed whereby the inside the electrocyte is negatively charged and the outside has a net positive charge[2]. By stimulation by a motor neuron, the innervated sides of the cells become depolarized before the un-innervated sides (Innervated: side of a cell which is attached to a nerve ending). This results in a temporary

potential gradient on each cell membrane, all pointing in the same direction. Immediate and total discharge then takes place. Leading up to the discharge, motor-neurons deliver nerve impulses from the brain, which, when they reach the electrocytes, cause the activation of acetylcholine. Acetylcholine diffuse across the synaptic cleft (the gap between the end of the motor-neuron and the electrocyte), and into an acetylcholine receptor on the cell membrane. This impulse causes an ion channel to open, where-after extracellular ions can then enter the cell and the depolarization process occurs. The simultaneous discharge of electricity from 200 000 electrocytes is achieved by specialized features of the motor-neurons.

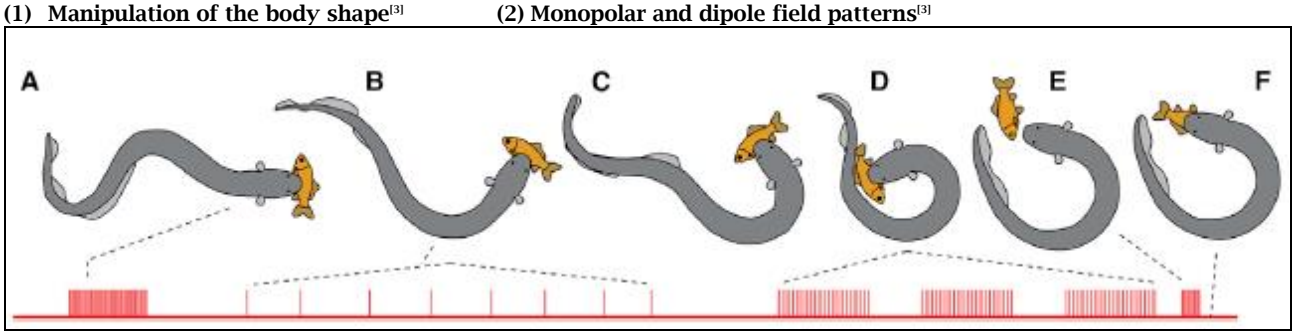
The unique capabilities of electric eels have captured the imagination of well-known pioneers in the field of electricity. Luigi Galvani and Allesandro Volta who studied these organisms are recognized as the founders of electrophysiology and electrochemistry. In addition, Michael Faraday has extensively tested the properties of the electric eel. By pressing copper paddles and saddles against an electric eel, he could measure electric impulses produced by the organism. Faraday subsequently determined and quantified the direction and magnitude of the electric current produced by the eel. He in fact proved that the eel's impulses were electrical in nature, by the observation of sparks and deflections on his galvanometer.



(1) Manipulation of the body shape[3]



(2) Monopolar and dipole field patterns[3]



(3) Series of attack positions from monopolar to dipole, showing voltage discharge patterns[3]

Very interesting research has lately shown that by creating a dipole effect by curling up their bodies, electric eels can concentrate the electric field, enabling the more effective disabling of their preys. Because the eel's electric organs span most of their body lengths, the positive (head) and negative (tail) are separated relatively far from each other. Typically an attack would be "monopolar", with the positive field from the head closest to the prey. However, when the prey does not fatigue rapidly enough, the eel curls up an a fashion such that the positive and negative fields are brought closer to each other, which results in a doubling of the strength of the electric field. A detailed description of this behavior is available in Catania (2015)[3]. Southern Africa does not have any electric eels. Skelton (1993)[4] describes four species of eels of the genus *Anguilla* found in southern Africa, *A. mossambica* (Longfin eel), *A. bicolor bicolor* (Shortfin eel), *A. bengalensis labiata* (African mottled eel) and *A. marmorata* (Madagascar mottled eel), but no mention is made of their potential to generate electricity.

[1] http://www.chm.bris.ac.uk/webprojects2001/riis/electriceel3.htm
[2] Traeger, L.L. *et al.* 2015. Unique patterns of transcript and miRNA expression in the South American strong voltage electric eel *(Electroporus electricus*). *MBC Genomics*. 16:243.
[3] Catania, K.C. 2015. Electric Eels concentrate their electric fields to induce involuntary fatigue in struggling prey. *Current Biology* 25, 2889 - 2898
[4] Skelton, P.H. 1993. 'n Volledige Gids tot die Varswater vise van Suider-Afrika. Southern Boekuitgewers.

Long Term HF Propagation for January 2019: Courtesy Vincent Harrison ZS6BTY

The graph below shows the predicted F-layer Maximum Usable Frequency (MUF) for propagation from Pretoria[1] using monthly sunspot numbers from SILSO[2].

Local Propagation (up to 500 km): The F or F2 critical frequency (f_oF2) is the MUF for short range, near vertical incidence sky-wave (NVIS) propagation.

Long Distance Propagation: The MUF for a first hop of 4000 km in the cardinal directions is labeled North, East, South and West. They indicate the direction that propagation may be expected.

Worldwide Propagation Maps: http://www.parc.org.za/index.php?page=propagation

"*Prediction is difficult, especially when dealing with the future*". . . Danish Proverb. 73 Vincent, ZS6BTY

[1]FTZMUF2: A simple method of estimating the ionospheric parameters of foF2 and M(3000) with the aid of a home computer - Thomas Damboldt and Peter Süßmann, Deutsche Bundespost, December 1988.
[2] Silso 12-month forecasts of the monthly sunspot number (http://sidc.oma.be/silso/FORECASTS/prediML.txt)