

Dlaczego szympany nie grają w
baseball?

Czyli o rzucaniu, ale także
postrzeganiu i planowaniu

Grzegorz Karwasz

Toruń, 13/01/2022

dydaktyka.fizyka.umk.pl

The screenshot shows a web browser window with the URL http://dydaktyka.fizyka.umk.pl/nowa_strona/. The page layout includes a left sidebar with navigation menus, a main content area with news and announcements, and a right sidebar with featured articles.

Left Sidebar:

- Wykłady dla szkół
- Budowa i podstawowe właściwości materiałów
- Dydaktyka fizyki
- Dydaktyka kognitywistyczna
- Dydaktyka multimedialna
- Elektromagnetyzm
- Fizyka Ogólna dla AiR
- Fizyka współczesna
- Innovative methods of didactics
- Relacje nauka - wiara

Laboratoria:


- Doświadczenia komputerowe
- Laboratorium elektromagnetyzmu
- Laboratorium metodyki eksperymentu
- Laboratorium multimedialne

Zadania dla studentów:

- Zadania "czeskie"
- Zadania problemowe
- Zadania z algebry dla studentów (I rok)
- Zadania z analizy matematycznej dla studentów

Main Content Area:


Szanowni Państwo,
zapraszamy Państwa na XIV Ogólnopolskie Seminarium Dydaktyki Fizyki "Komputer w Szkolnym Laboratorium Przyrodniczym", które odbędzie się w dniach od 2 do 4 grudnia 2021 roku w formie stacjonarnej i zdalnej na platformie WEBEX.



Czytaj dalej

Świetne widowisko na nocnym niebie - zorza polarna nad Polską
admin, sob., 2021-10-30 14:21

Już w nocy z 30 na 31. października możemy spodziewać się, o ile dopisze pogoda, spektakularnego widowiska świetlnego na nocnym niebie nad Polską.
Dostrzec będzie można - wydawałoby się zarezerwowaną dla obszarów okołobiegunowych - zorzę polarną! :)



Right Sidebar:

grudzień 2021

Fizyka i zabawki

Fizyka zabawek

Droga do fizyki współczesnej

Dołącz i doświadczenia

Taskbar: Wpisz tu wyszukiwane słowa, 1°C Pochmurnie, 19:35 13.12.2021

Fizyka i zabawki



The screenshot shows a web browser window with the following elements:

- Browser Tabs:** Public Stat, Two-cente, How do fil, Projekty Z, stratocum, vajiram Str, Szukaj na, Physics an, SA No One C.
- Address Bar:** http://dydaktyka.fizyka.umk.pl/zabawki/
- Website Content:**
 - Five flags representing the United Kingdom, Poland, Germany, France, and Italy.
 - Five underlined links: [Physics and Toys](#), [Fizyka i Zabawki](#), [Physik und Spielsachen](#), [Physique et Jouets](#), and [Fisica e Giocattoli](#).
 - A link: [Physics is Fun](#)
 - Text: Commission of the European Communities, Research Directorate-General, Structuring the European Research Area Specific Support Action: Science and Society Project No. 020772 PhysFun
 - Logos for various institutions: UNIVERSITA' TRIESTE, UNIVERSITA' DI TORINO, UNIVERSITA' DI PADOVA, UNIVERSITA' DI VERONA, UNIVERSITA' DI TRIESTE, UNIVERSITA' DI TRIESTE, SOLITON.
- Images:**
 - A green bubble machine on the left with a circular window showing colorful bubbles.
 - A wooden stacking toy on the right, featuring a stack of colorful rings and a small figure on top.

At the bottom of the browser window, the Windows taskbar is visible with the search bar containing 'Wpisz tu wyszukiwane słowa', several application icons, and system tray information showing 3°C, Przew. pochmur., and the date 14.12.2021.

Cztery działy fizyki

← → ↻ Niezabezpieczona | http://dydaktyka.fizyka.umk.pl/zabawki1/index-pl.html

Home


Mechanika

Optyka

Termodynamika

Elektryczność i magnetyzm

🇬🇧 🇫🇷
🇩🇪 🇮🇹

 **Fizyka** i **zabawki**



- ▶ [Najciekawsze](#)
- ▶ [Prawa fizyczne](#)
- ▶ [Pojęcia fizyczne](#)
- ▶ [Zjawiska fizyczne](#)

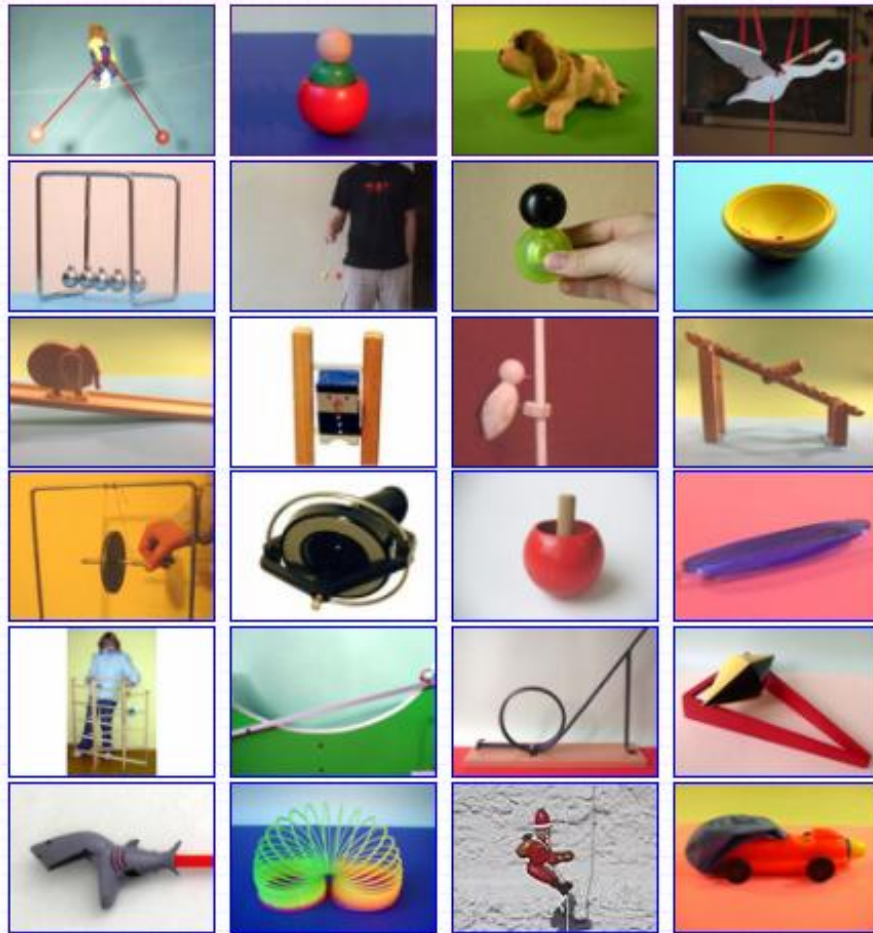
[Autorzy](#)

- Co to jest Mechanika? Pani, która pracuje w myjni samochodowej?
A Termodynamika? Rodzaj kulturystyki, tylko że na ciepło?
- Są to działy Fizyki! [Mechanika](#) to nauka o ruchu, [termodynamika](#) to nauka o ciepłe.
- A co to Fizyka?
- Fizyka, to według takiego starożytnego myśliciela, Arystotelesa, nauka o Naturze, czyli o tym co się da dotknąć.
- Czyli Fizykę da się dotknąć?
- Oczywiście! A wszystko czego nie da się dotknąć, nazywał Arystoteles poza-naturą, czyli meta-fizyką.
- Mogę się pobawić?
- Jak najbardziej, na pewno coś odkryjesz!

Zapraszamy do zabawy, wszystkim, co się da dotknąć, czyli Fizyką. Dotknąć, przynajmniej wirtualnie, czyli na ekranie komputera.

(A czego nie da się dotknąć pozostawmy metafizykom.)

Mechanika, czyli nauka o ruchu (i bezruchu)



Mechanika

- ✦ [Poczucie równowagi](#)
- ✦ [Wańka-wstańka](#)
- ✦ [Piesek-kiwaczek](#)
- ✦ [Wędrownny ptak](#)

- ✦ [Wahadło Newtona](#)
- ✦ [Riki - tiki](#)
- ✦ [Skaczące piłeczki](#)
- ✦ [Dropper - poper](#)

- ✦ [Kroczące zwierzaki](#)
- ✦ [Ludek na drabinie](#)
- ✦ [Pracowity dzieciół](#)
- ✦ [Koziołki-fikołki](#)

- ✦ [Wahadło Maxwella](#)
- ✦ [Żyroskop](#)

Playing darts

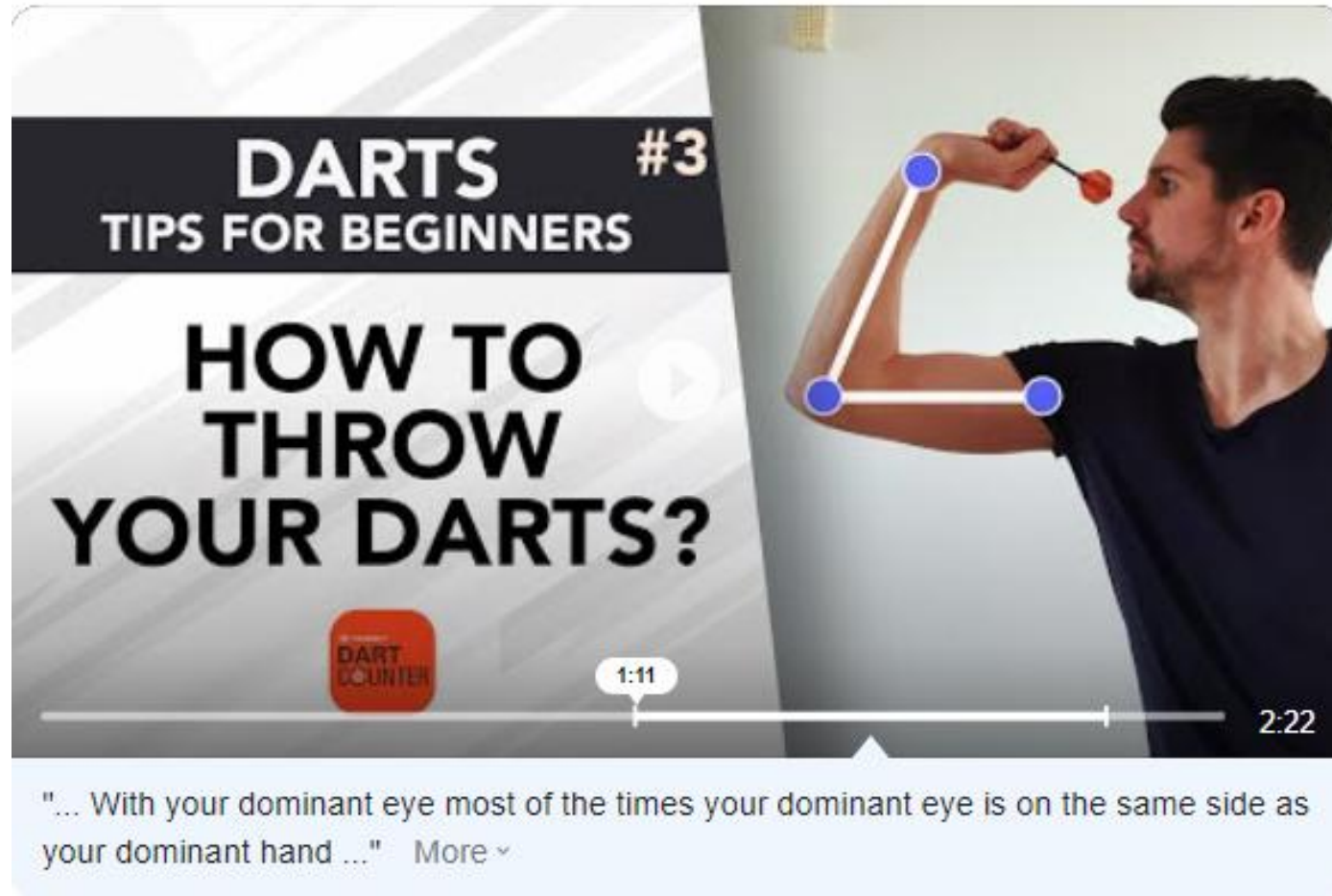


The physics and mechanics behind dart throws tell us that one of the most important aspects to master is for the body to remain still during the release of the dart.

Only the forearm, arm, and wrist should move to ensure that the dart follows the most accurate and efficient path through the air.

[Dart flights](#), like arrow fletchings, provide aerodynamic stabilization to the dart during flight. Large shapes tend to give the player a more controlled throw, while smaller flights tend to offer faster more aggressive throws.

Playing darts



DARTS #3
TIPS FOR BEGINNERS

HOW TO THROW YOUR DARTS?

DART COUNTER

1:11 2:22

"... With your dominant eye most of the times your dominant eye is on the same side as your dominant hand ..." More ▾

<https://www.youtube.com/watch?v=dMtXEiV0-gU>

Celuj nieco wyżej, niż upatrzony punkt

Playing darts

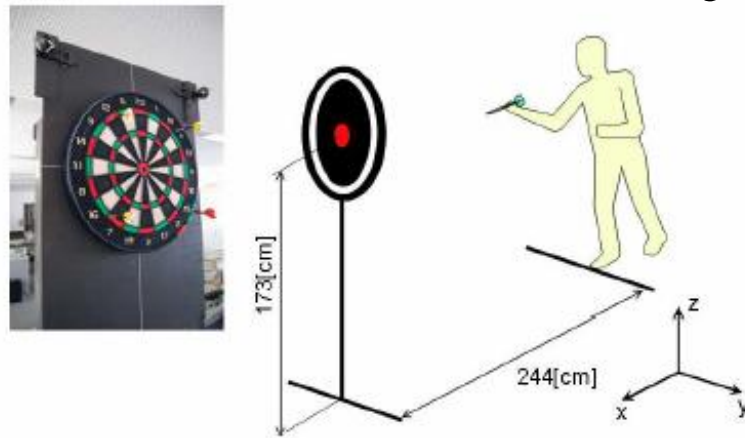


fig. 1. Setting of the dart board and the standing location of the subjects

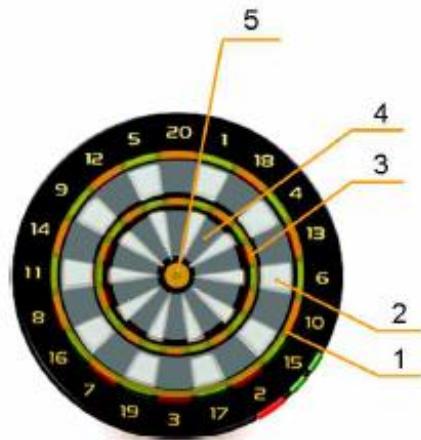


Fig. 2. Scoring system

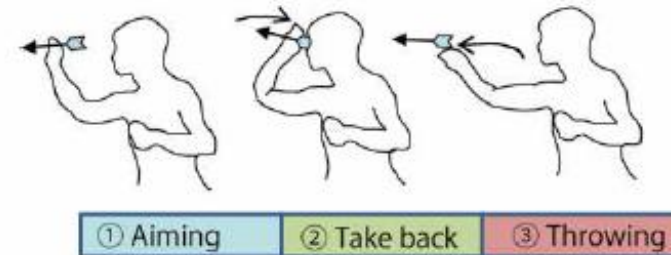
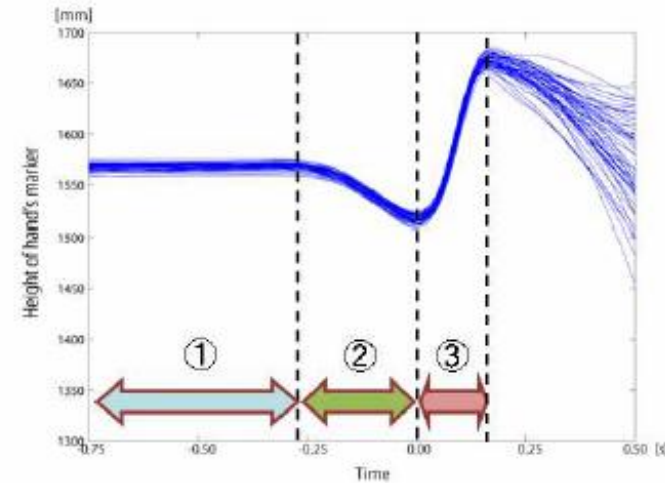


Fig. 3. Motion phases for throwing darts

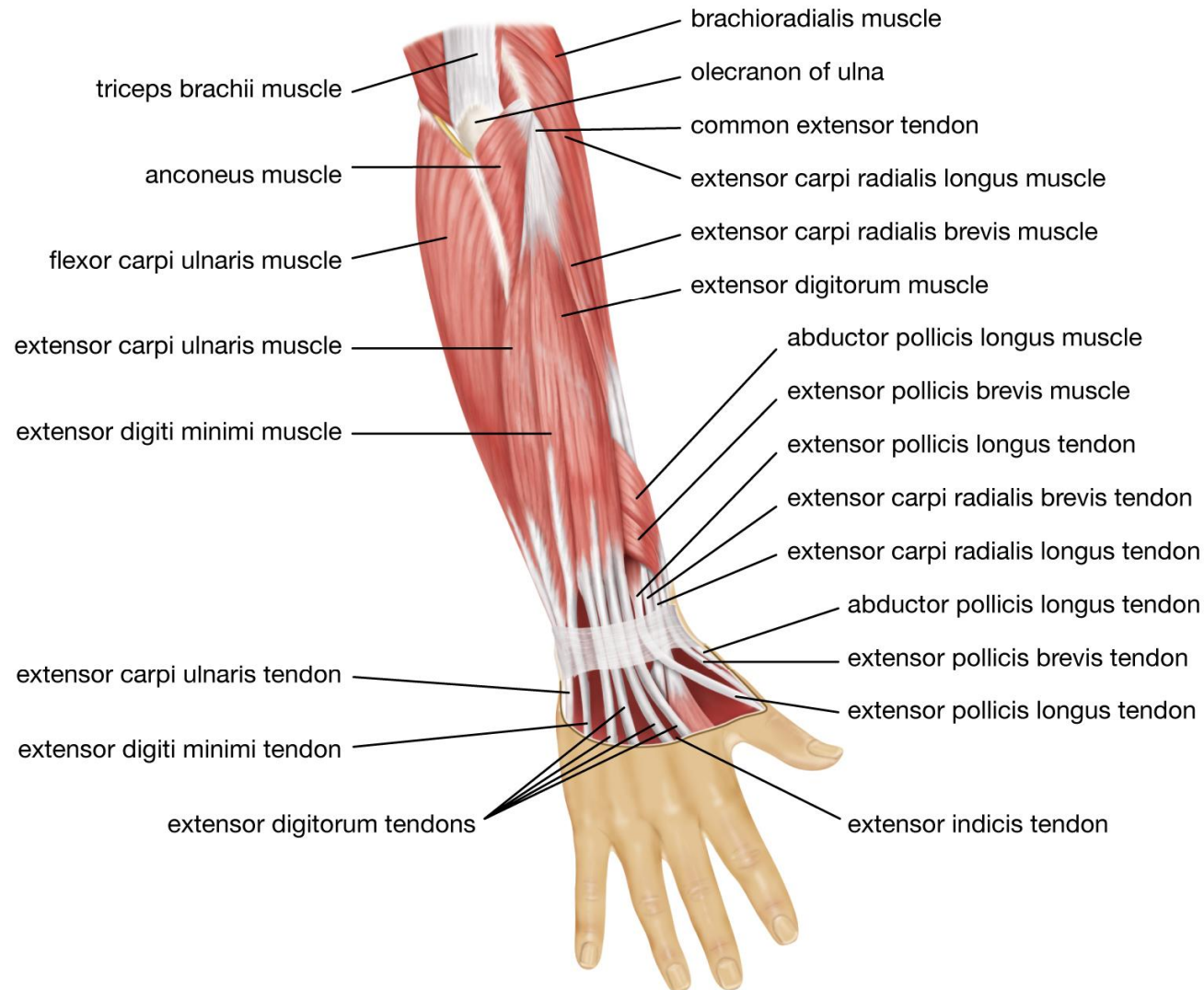
of the hand's marker goes from a minimum value maximum value (see Fig. 3).

D. Joint torque calculation

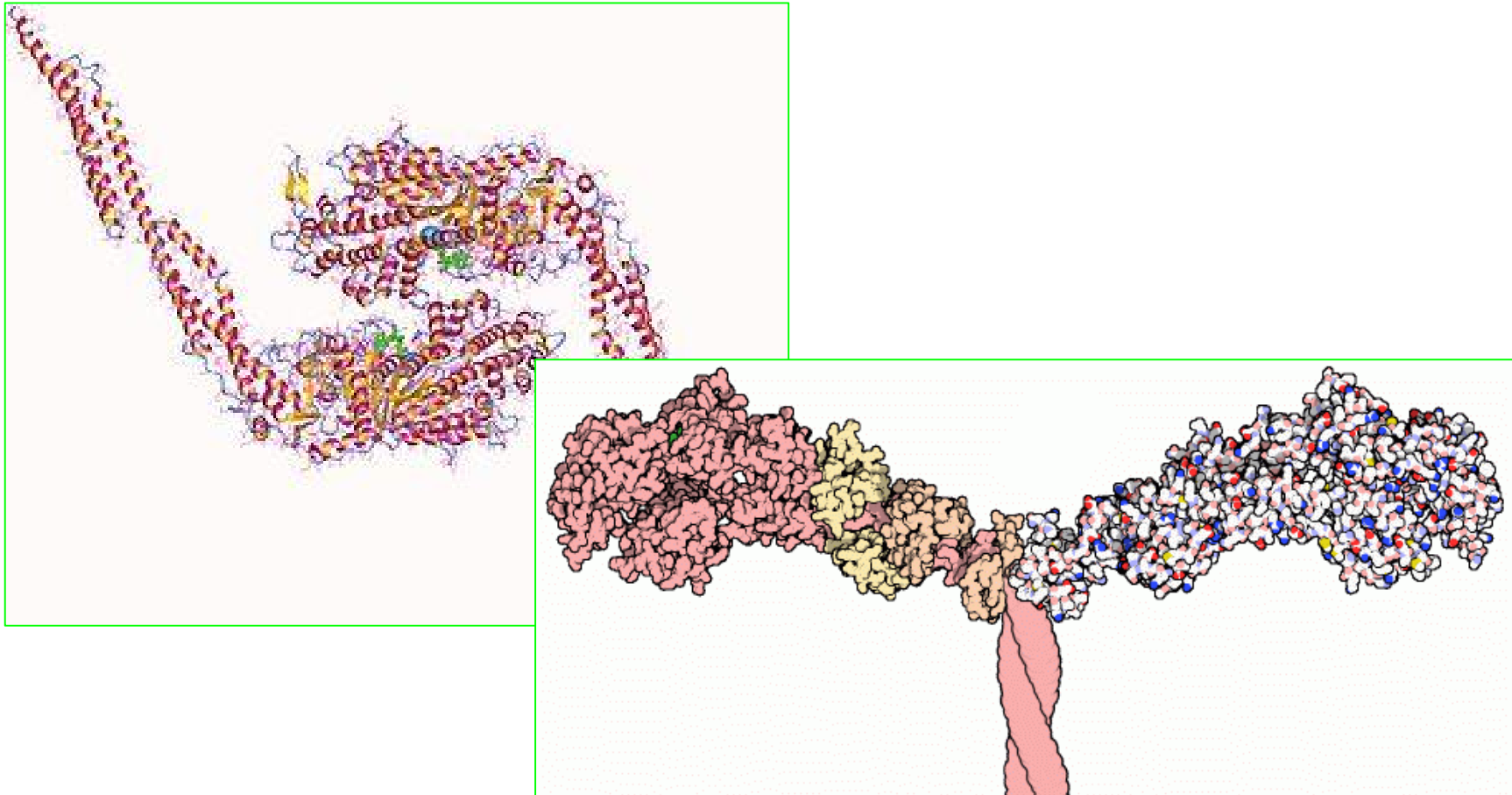
Tomova Tamei, Chihiro Obavashi, Tomohiro Shibata,
 Throwing darts utilizes the interaction torque of the elbow joint
 August 2011 Annual International Conference of the IEEE Engineering in Medicine and Biology Society.
 DOI: [10.1109/IEMBS.2011.6090302](https://doi.org/10.1109/IEMBS.2011.6090302)

Jak złożona jest ludzka ręka...

Posterior muscles of the forearm



Miozyna – sprężyna mięśni



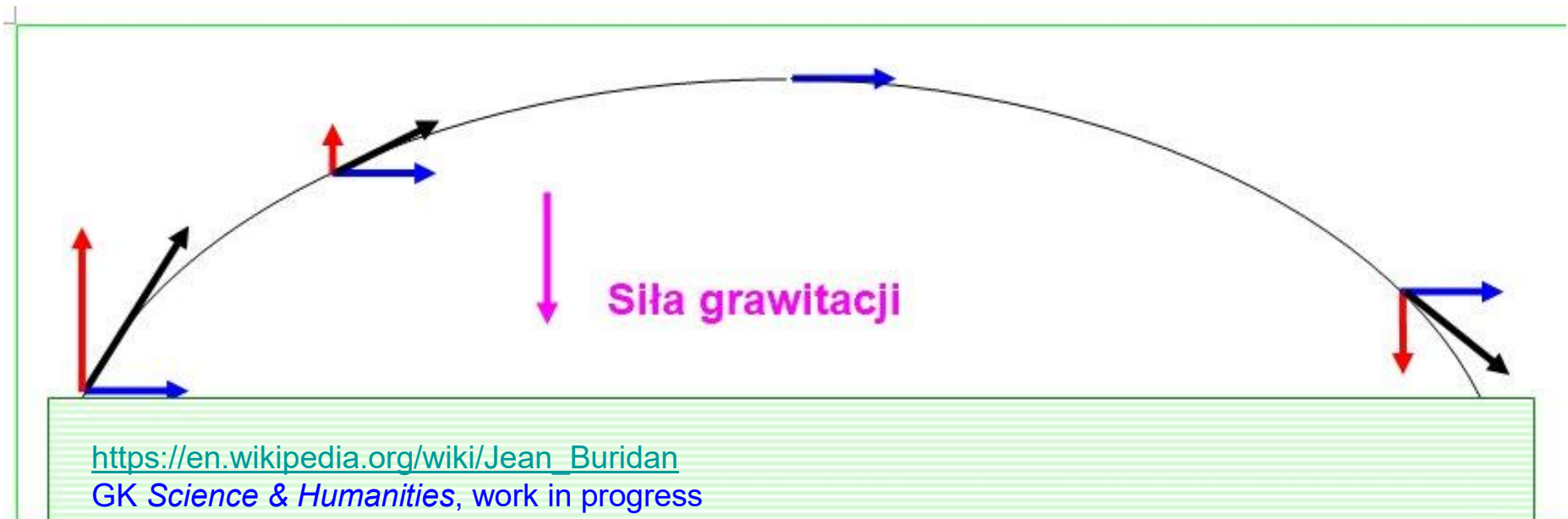
<http://www.rcsb.org/pdb/explore/explore.do?structureId=1g8x>

Attribution, <https://commons.wikimedia.org/w/index.php?curid=33859>

Jean Buridian (1300-1361)

Tak pisał w *Quaestiones* będących komentarzem do *Fizyki* Arystotelesa⁵³:

Kiedy napędzający wprawia jakieś ciało w ruch, udziela mu określonego **pędu**, tj. możliwości poruszania się w kierunku, który napędzający ciału nadał – czy to w górę, czy w dół, w bok lub po okręgu. Nadany pęd jest proporcjonalny do prędkości. To z powodu pędu kamień porusza się po tym, jak rzucający go przestał go napędzać. Ale z powodu oporu powietrza (a także z powodu grawitacji kamienia), który działa w kierunku przeciwnym do kierunku ruchu, pęd maleje wraz z upływem czasu. Z tego powodu ruch kamienia będzie stopniowo coraz wolniejszy aż w końcu pęd na tyle zmaleje albo zaniknie, że grawitacja kamienia przeważy i skieruje kamień w kierunku jego miejsca naturalnego [czyli w kierunku środka Ziemi]. Według mnie należy tę opinię przyjąć, ponieważ inne wyjaśnienia okazały się fałszywe a wszystkie zjawiska są zgodne z tym wyjaśnieniem.



Składanie ruchu (jednostajnego) w dwóch kierunkach to np.

- wznoszenie się jumbo-jeta (nad Tokyo)



„Arystoteles” (tak naprawdę nie on):

- Wystrzelona strzała leci w górę, a kiedy straci „rozpęd”, spada w dół



Gdyby tak rozumowali angielscy łucznicy pod Agincourt (1415), to by przegrali bitwę

Six hundred years ago today, on the morning of 25th of October 1415, a small band of English archers commanded by Henry V won a great military victory in France in [Hundred Years War](#)

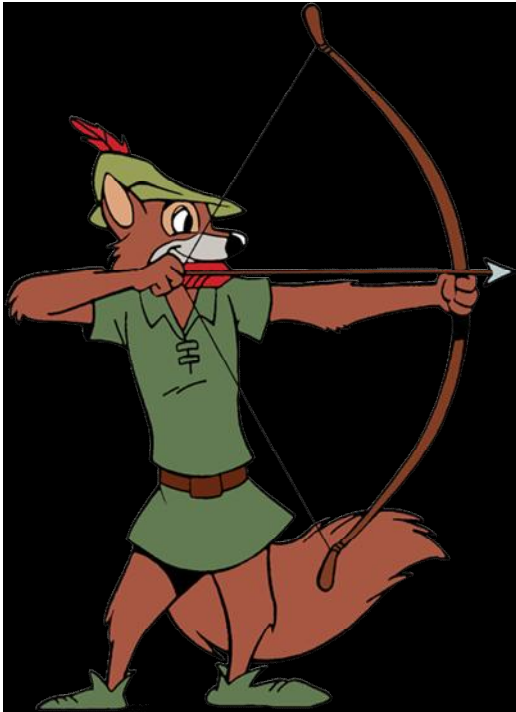
https://en.wikipedia.org/wiki/Battle_of_Agincourt

https://en.wikipedia.org/wiki/Battle_of_Crecy **Bitwa pod Crecy (1346)**

Długie angielskie łuki:

- Długie łuki znaleziono w wykopaliskach z 2500 lat p.n.e.

6 feet (1.8 m) long, with a 3-foot (910 mm) arrow: 400–490 newtons, 300-350 m

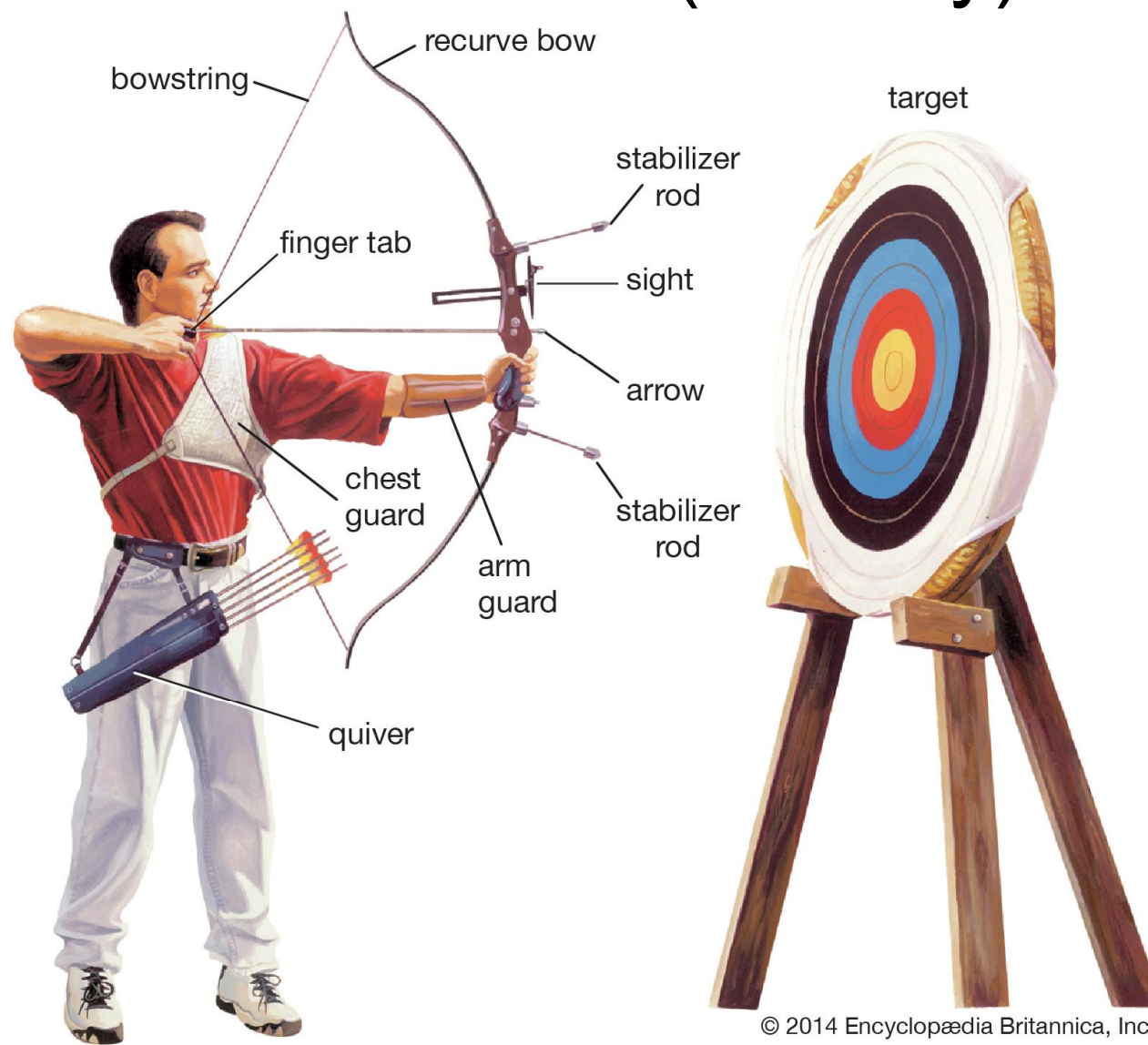


- Dlaczego każdy z nich trzyma łuk pod innym kątem?

https://en.wikipedia.org/wiki/English_longbow <https://www.disneyclips.com/imagesnewb/images/robin-hood.png>

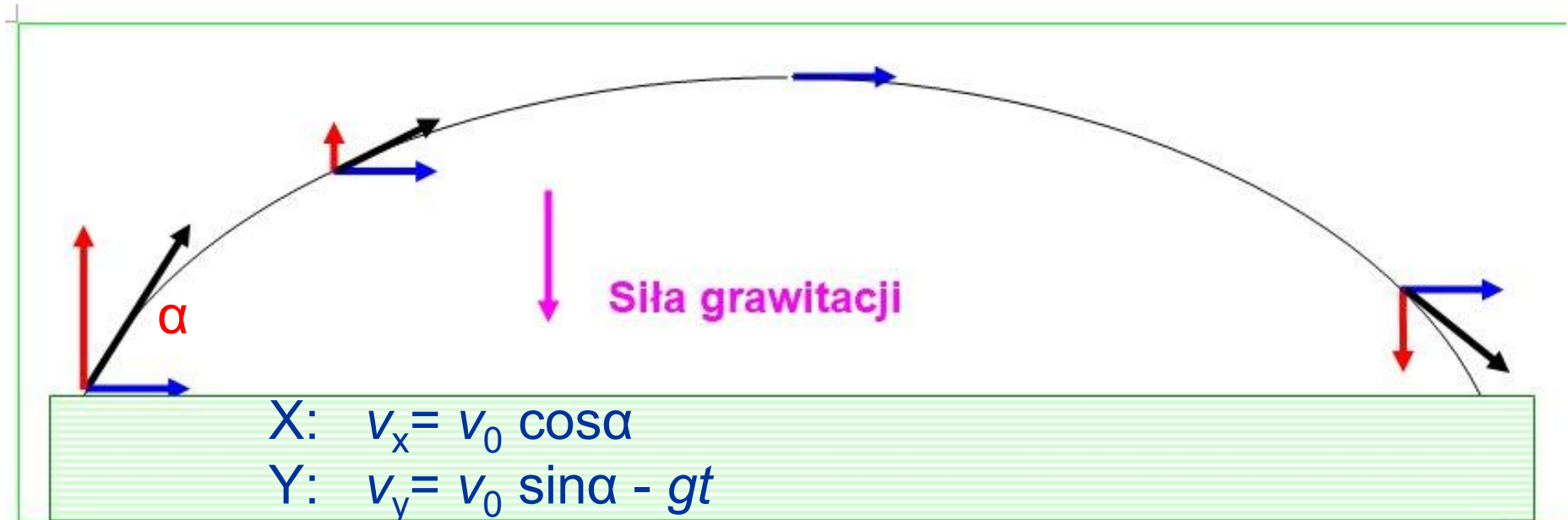
Added by [Ekreture](#) Posted in [Yeoman archers](#)[User blog:Ekreture/Ashigaru vs Yeoman Archer](#)[User blog:MilenHD/Yeo](#)

Łucznictwo (archery)



<https://www.britannica.com/sports/archery>

Rzut ukośny



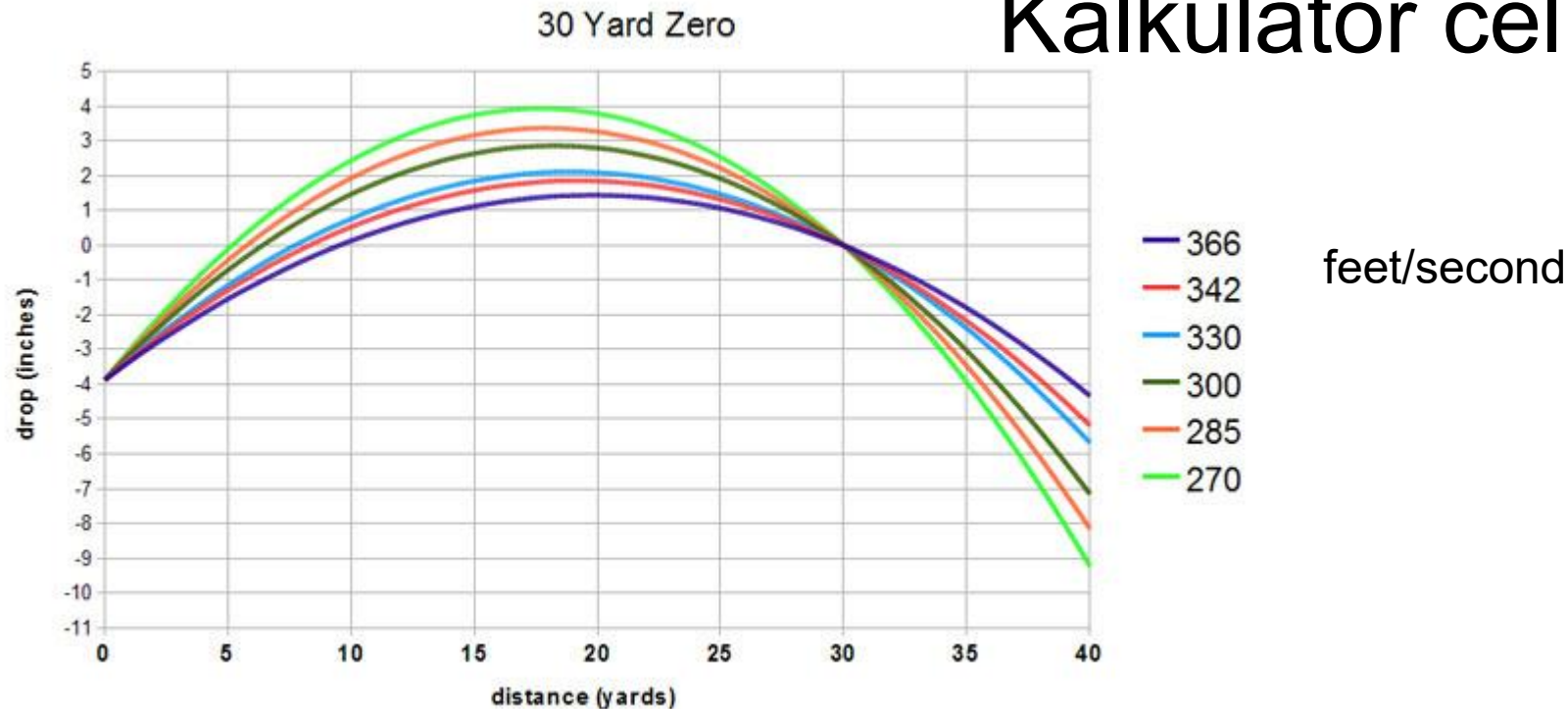
X: $x(t) = v_0 t \cos \alpha$ (ruch jednostajny)

Y: $y(t) = v_0 t \sin \alpha - \frac{1}{2} g t^2$ (rzut w górę z $v_0 \sin \alpha$)

Czas lotu: gdy $y(t) = 0 \rightarrow t_1 = 0, t_2 = (2v_0 \sin \alpha) / g$

zasięg $z = (v_0 \cos \alpha) (2v_0 \sin \alpha) / g = v_0^2 (2 \sin \alpha \cos \alpha) / g$

Kalkulator celu



Before getting into the nitty gritty and some fun graphs, let's first get a couple of things straight. The **laws of physics**, and more specifically those of gravity and fluid dynamics, govern arrow flight and these laws *do not change*. If I hear at the range or read one more claim on any message board that we have re-written or changed the laws of physics with our advancements in archery technology, I'll personally be tempted to dig up Sir **Isaac Newton and resuscitate him** so that he can beat whoever claims such nonsense with a wet noodle (Archery Report does not condone physical violence that results in any real harm!) Our understanding of the laws of physics and their governing equations deepens and grows, but the law themselves *do not change, nor will they ever change*. Even if someone markets a bow that shoots laser beams, it will still have to follow these same laws of physics.

Angielscy łucznicy: rozwiązanie



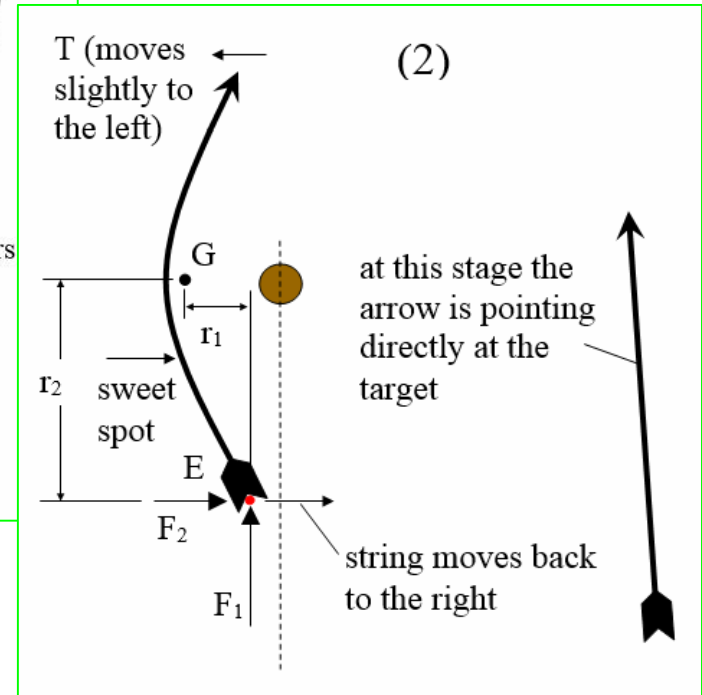
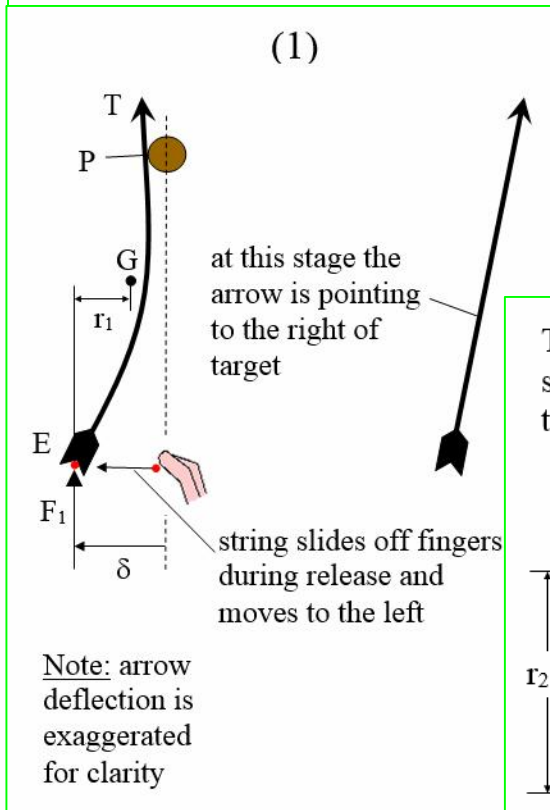
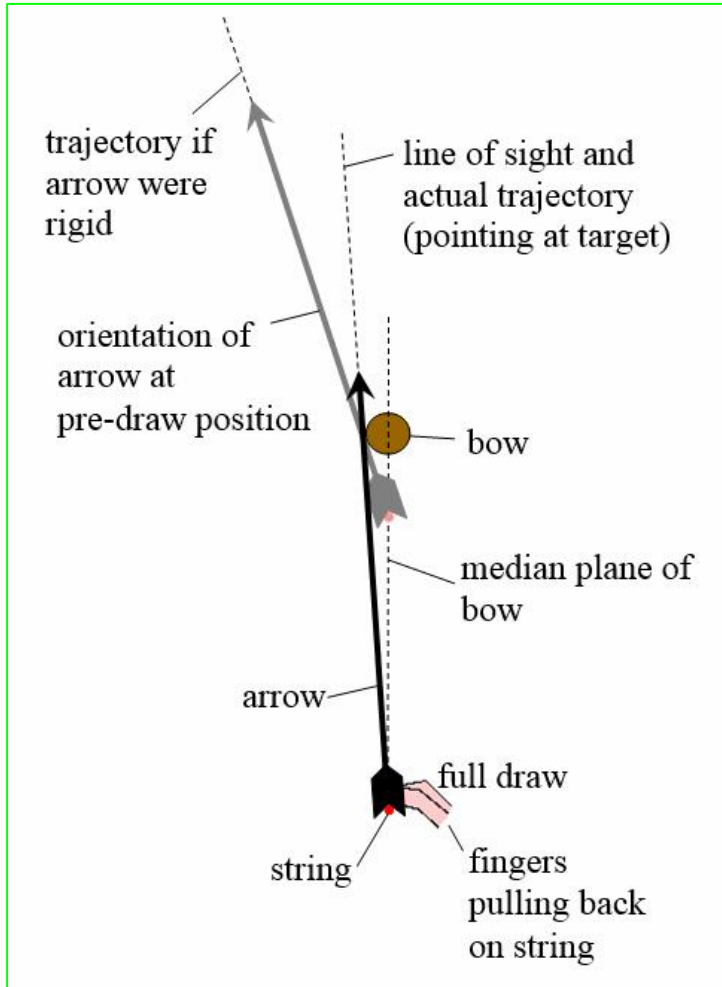
<http://www.theinfinitecurve.com/tag/agincourt/>

$$\text{Zasięg } z = v_0^2 (2\sin\alpha \cos\alpha)/g = (v_0^2/g) \sin(2\alpha)$$

Innymi słowy: $z = (2E/mg) \sin(2\alpha)$ - potrzebny długi łuk

Maksymalny zasięg, gdy $\sin(2\alpha) = 1$, czyli $\alpha = 45^\circ$

Łucznictwo a fizyka



Łucznictwo na olimpiadzie

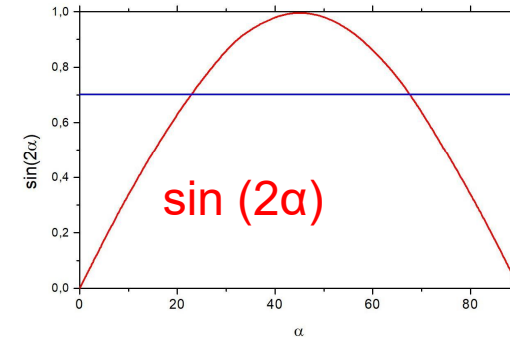


Nowy pomysł na artylerię:

$$\text{Zasięg } z = (v_0^2/g) \sin(2\alpha); \quad 0 \leq \alpha \leq 90^\circ$$



haubica



moździerz

Możemy to sprawdzić

Colorado Phet

The screenshot shows the PhET Projectile Motion simulation in a web browser. The browser's address bar displays the URL: https://phet.colorado.edu/sims/html/projectile-motion/latest/projectile-motion_en.html. The simulation area features a grey cylindrical launcher on a green ground. A red and yellow pumpkin is positioned at the top of the launcher, which is 10 m high. The pumpkin is launched at an angle of 65 degrees. Three blue parabolic trajectories are shown, representing different launch speeds. A small figure of a person stands on the ground, and a red bullseye target is located 15.0 m from the base of the launcher. The right-hand side of the interface contains a control panel for the 'Pumpkin' object, with the following settings: Mass: 5 kg, Diameter: 0.37 m, Air Resistance: unchecked, Drag Coefficient: 0.60. Below this, there are sections for 'Velocity Vectors' and 'Acceleration Vectors', each with checkboxes for 'Total' and 'Components'. At the bottom of the simulation, there is a control bar with an 'Initial Speed' slider set to 12 m/s, a 'Normal' vs 'Slow' speed selector, and a 'Reset' button. The PhET logo is visible in the bottom right corner.

https://phet.colorado.edu/sims/html/projectile-motion/latest/projectile-motion_en.html

Parabola, czy krzywa balistyczna?

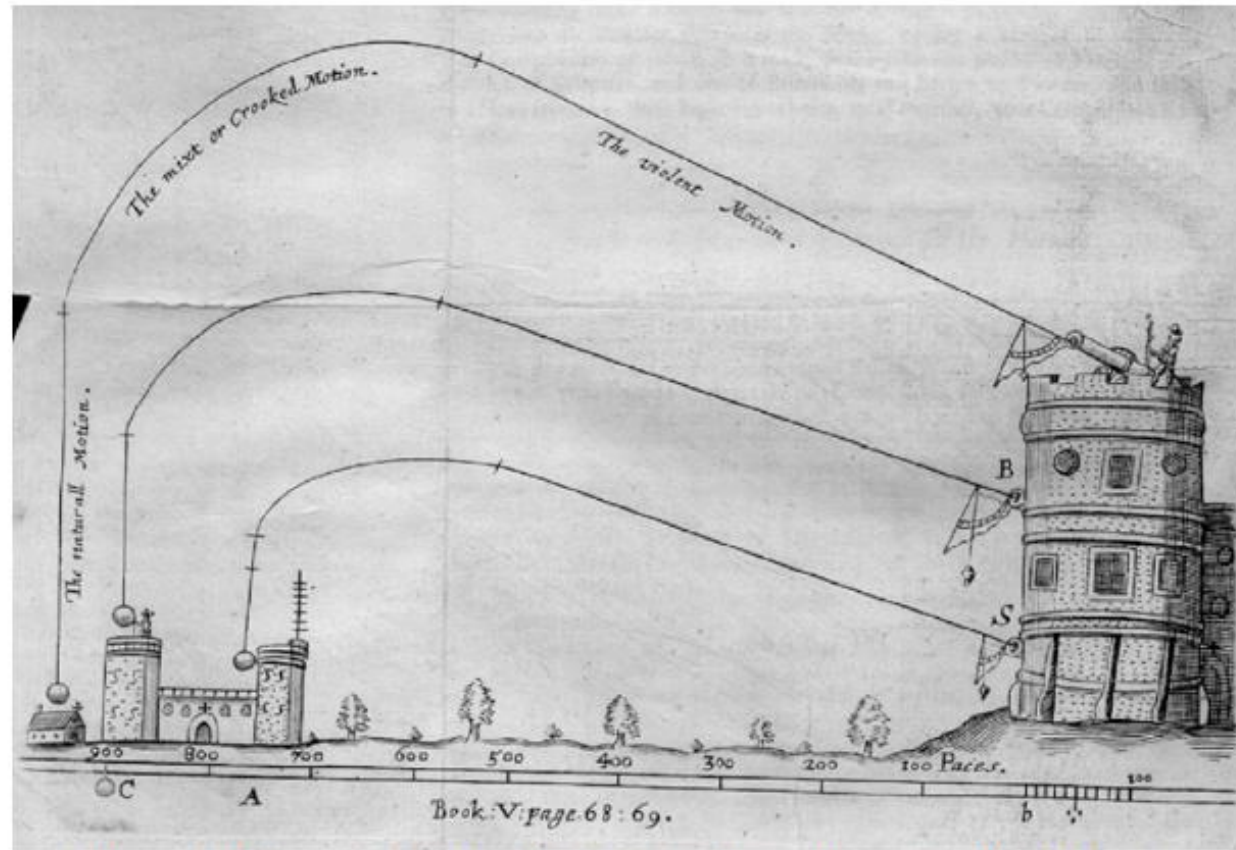


Figure 5. Diagram of projectile motion in Samuel Sturmy's 'The Mariners Magazine. 5: Mathematical and Practical Arts' published in 1669. [18]. This image was recently discussed by Stewart [19].

Aristotle, projectiles and guns

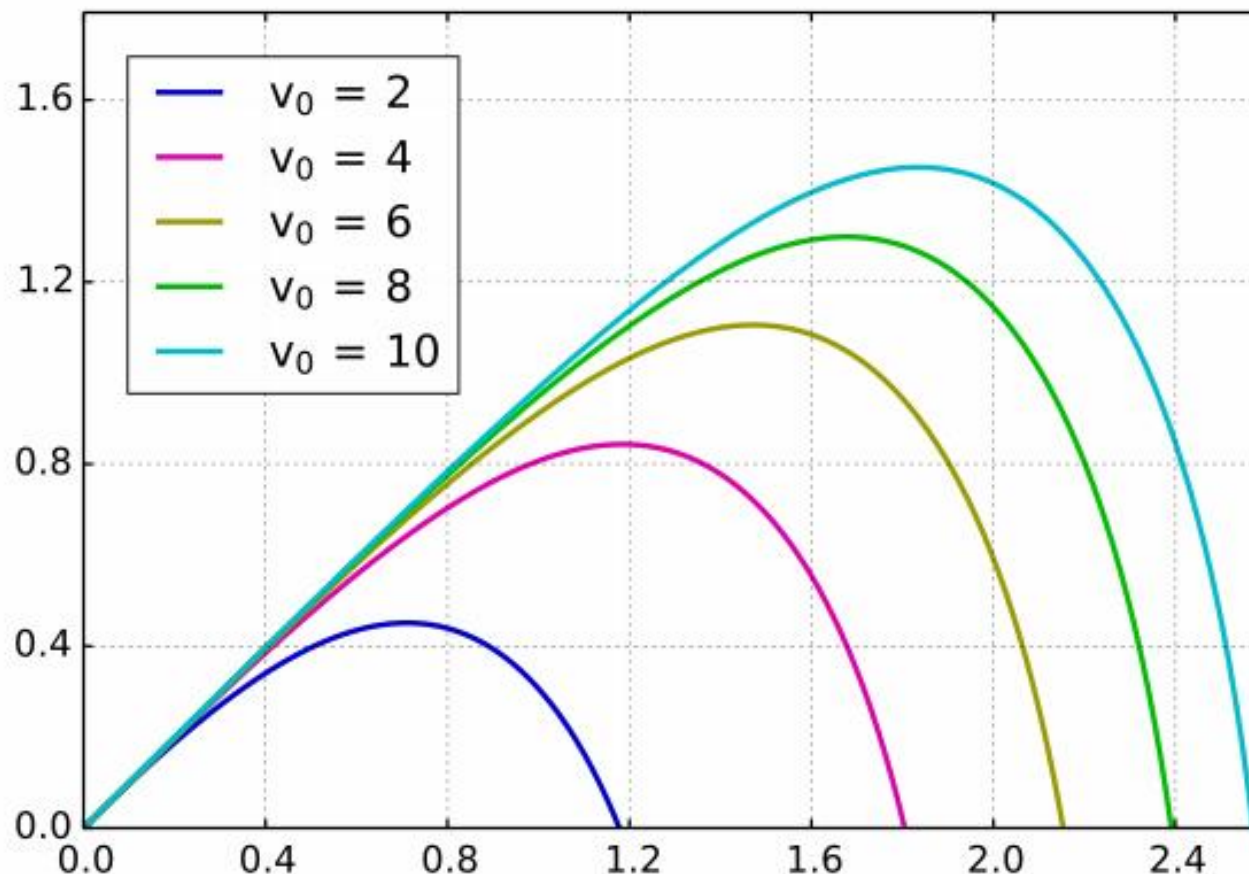
Stephen M. Walley

SMF Fracture and Shock Physics Group, The Cavendish Laboratory,

J.J. Thomson Avenue, Cambridge, CB3 0HE, UK

Jak leci strzała z łuku (a jak piłka)?

Opór powietrza → krzywa balistyczna



Strzał do małpy



Jaką prędkość musi mieć pocisk, i pod jakim kątem musi być wystrzelony, aby trafił w małpę?

Physics 101: The Hunter – monkey problem <https://www.youtube.com/watch?v=G25Y3MJBR-0>

Jak to rozwiązać?

1. Wybrać układ współrzędnych (dogodny dla dalszych obliczeń)
Jeśli ten wybrany nie będzie dogodny – zmienimy.

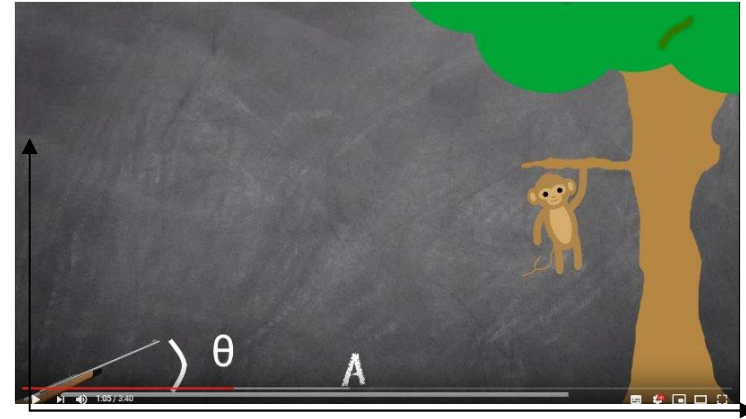
2. Piszemy równania ruchu małpy i kuli w tym układzie współrzędnych

3. Małpa: $x_m(t) = d$; $y_m(t) = h - \frac{1}{2}gt^2$ (spada pionowo)

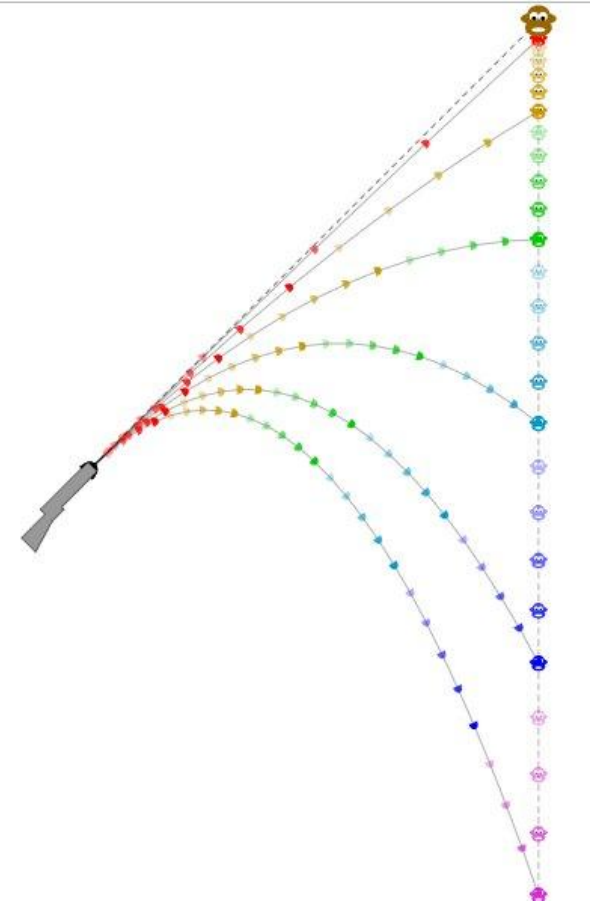
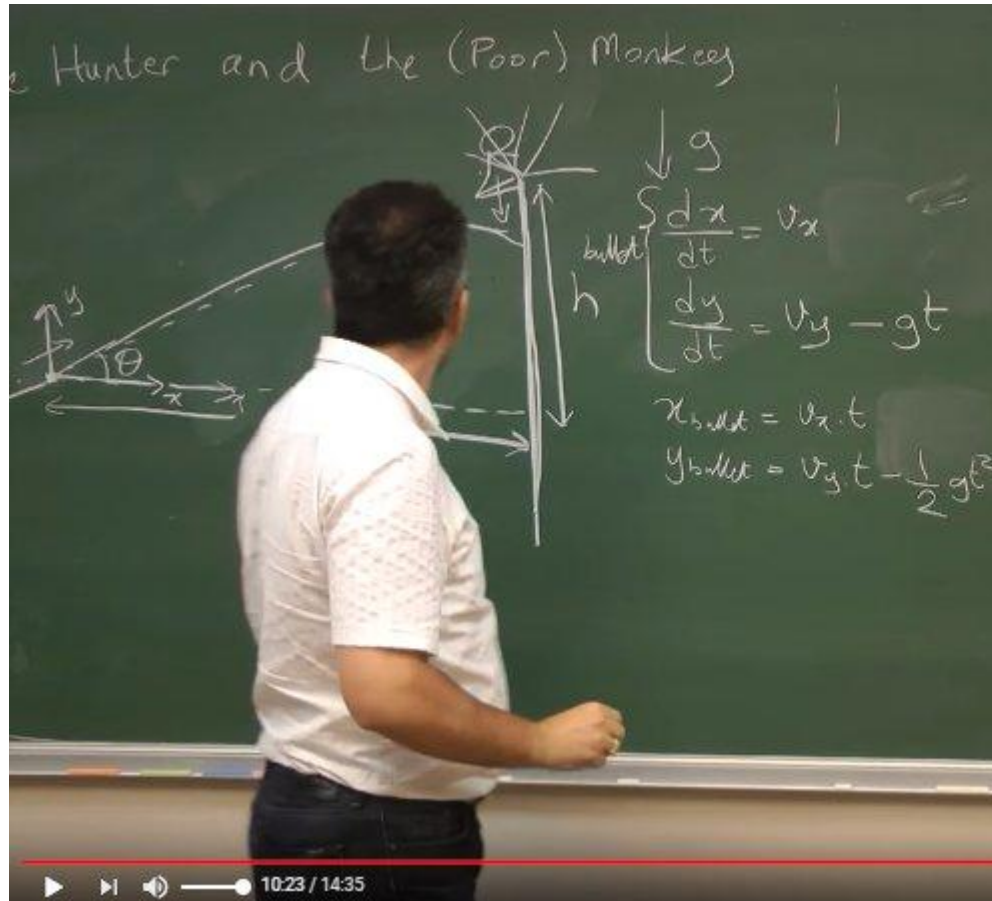
Kula $x_k(t) = v t \cos \theta$; $y_k(t) = v t \sin \theta - \frac{1}{2}gt^2$ (leci po paraboli)

Jeśli kula ma trafić, to istnieje takie t , że $x_m = x_k$ oraz $y_m = y_k$

4. Teraz już tylko wyrazić $\cos \theta$ i $\sin \theta$ przez h i d i rozwiązać (znaleźć t)



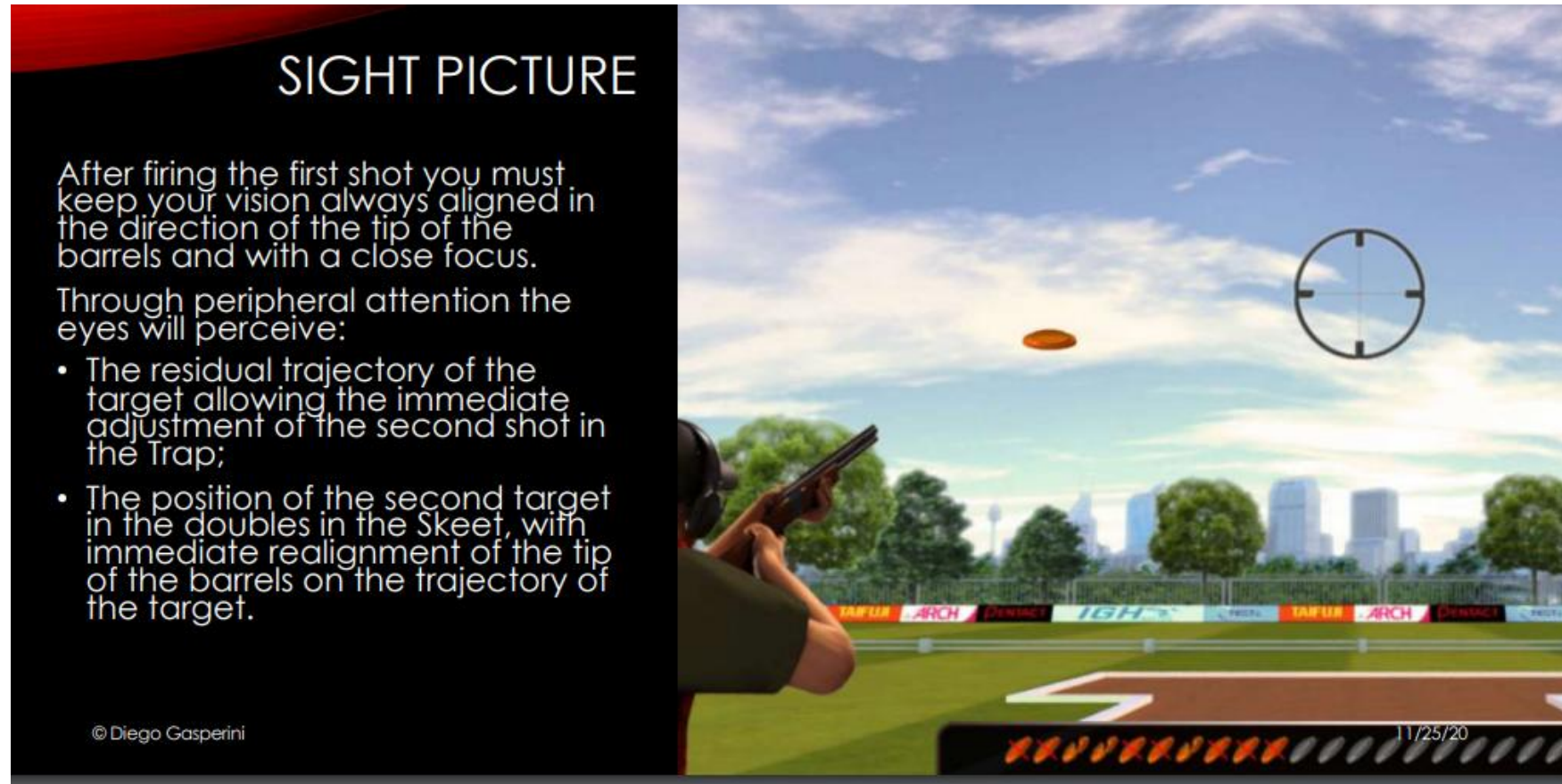
(przydługi) strzał do małpy



[https://upload.wikimedia.org/wikipedia/commons/a/a9/The monkey and the hunter SMIL.svg](https://upload.wikimedia.org/wikipedia/commons/a/a9/The_monkey_and_the_hunter_SMIL.svg)

The Hunter and he (poor) monkey <https://www.youtube.com/watch?v=BXq-2qMfqxw>

(Clay) pigeon shooting



(Clay) pigeon shooting

INITIAL MOVEMENT ²⁴ SKEET – READING THE TRAJECTORY

- Consciously keep the tip of the barrels within the picture while calling;
- Be sure to perceive the tip of the barrels starting the movement;
- Left hand supports the gun to begin the initial movement toward the leading point of the target;
- Head holds the same position; eyes begin to align with the sight line of the shotgun;
- Right hand begins to lift up the stock in the vertical axis while the body is still rotating.



(Clay) pigeon shooting

Visual Target Tracking in Clay Pigeon Shooting Sports: Estimation of Flight Parameters and Throwing Range

Franz Andert¹, Simon Freudenthal² and Stefan Levedag³

¹Institute of Flight Systems, Unmanned Aircraft Dept., DLR (German Aerospace Center), Braunschweig, Germany

²Technische Universität Braunschweig, Braunschweig, Germany

³Head of the DLR-Institute of Flight Systems, Braunschweig, Germany

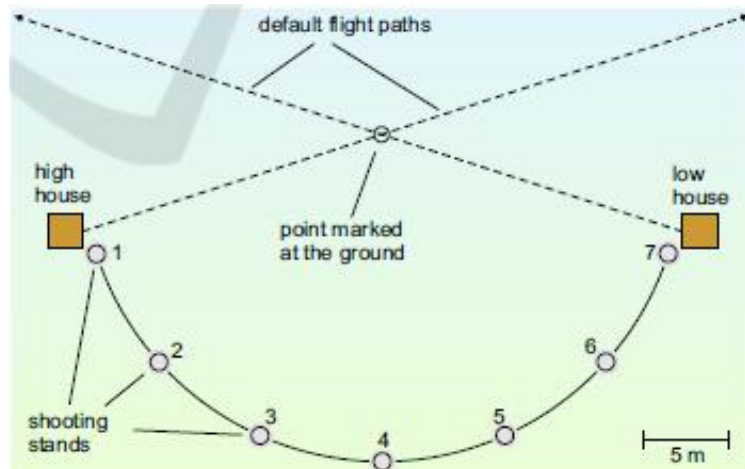
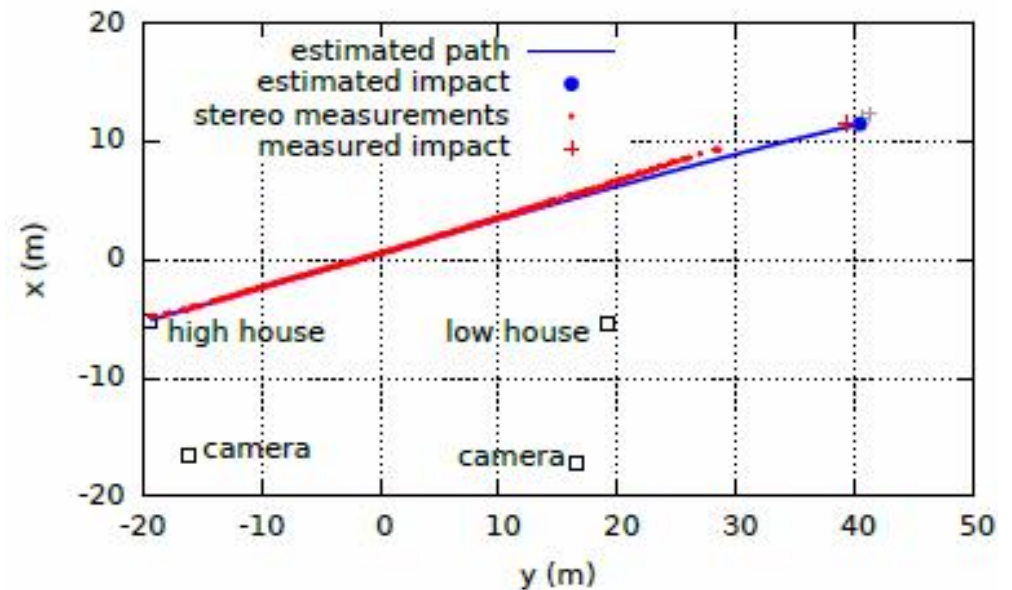


Figure 1: Schematic overview of Skeet shooting. The clay target is launched from the high and the low house and must be shot from the stands 1–7. Both flight paths must cross a point over the center marked at the ground.



(Clay) pigeon shooting

Table 1: Flight state values, coefficients, and parameters.

Symbol(s)	Description
Flight State (components of \mathbf{x}), disc hull without spin	
\mathbf{p}	geodetic position: $(x, y, z)^\top$, local Cartesian
\mathbf{v}	velocity vector: $(u, v, w)^\top$, rotated to body
ϕ	geodetic attitude: $(\Phi, \Theta, \Psi)^\top$, Euler angles
ω	rotation rates: $(p, q, r)^\top$, body-fixed
Constants (default values or measured)	
A	disc area size: 0.0095 m ²
d	disc diameter: 0.11 m
m	disc mass: 0.105 kg
\mathbf{I}	inertia tensor: $\text{diag}(1.33, 1.33, 2.57) \cdot 10^{-4}$ kg m ²
g	gravity acceleration: 9.81 m/s ² (default value)
ρ	air density: 1.184 kg/m ³ (default value)
Coefficients	
F_L, C_L	lift force, lift coefficient
F_D, C_D, K	drag force, drag coefficient, modeled helping constant
M, C_M	pitch moment, moment coefficient
N, C_N	yaw moment, moment coefficient
R, C_R	roll moment (neglected here)
Other variables	
\mathbf{R}_{fg}	rotation matrix: geodetic \rightarrow flight body
\mathbf{R}_{fa}	rotation matrix: aerodynamic \rightarrow flight body
$\mathbf{R}_{f\phi}$	rotation matrix: Euler angle change \rightarrow flight body
v_a	aerodynamic speed
α	angle of attack
ω_{spin}	disc rotation (yaw rate inside hull)
t	time (numbered time stamps)

Fig. 4 illustrates the factors which have an influence on the disc's motion, being dependent on the velocity, the angle of attack (i.e. the angle between the

3.3 Flight Trajectory Model

The equation system $\dot{\mathbf{x}} = f(\mathbf{x})$ to determine the flight trajectory can be derived from the forces as described in the given references. For the flight path calculations, the state \mathbf{x} refers to an imaginary non-spinning hull around the disc. The body-fixed x -axis is along the direction of flight, i.e. it corresponds with the velocity vector. The state components are geodetic position \mathbf{p} and attitude ϕ , and the hull-oriented velocity \mathbf{v} and turn rates vectors ω . Following the flight kinematics in (Lorenz, 2005), the differential equations for the state components are denoted:

– Position (derived from velocity):

$$\dot{\mathbf{p}} = \mathbf{R}_{fg}^\top \cdot \mathbf{v} \quad (1)$$

– Velocity (from forces and rotation):

$$\dot{\mathbf{v}} = \frac{1}{m} \cdot \mathbf{R}_{fa} \begin{pmatrix} -F_D \\ 0 \\ -F_L \end{pmatrix} + \mathbf{R}_{fg} \begin{pmatrix} 0 \\ 0 \\ g \end{pmatrix} - \omega \times \mathbf{v} \quad (2)$$

– Attitude (from turn rates):

$$\dot{\phi} = \mathbf{R}_{f\phi} \cdot \omega \quad (3)$$

– Turn rates (from pitch and yaw moments, and rotation):


$$\dot{\omega} = \mathbf{I}^{-1} \left(\mathbf{R}_{fa} \begin{pmatrix} 0 \\ M \\ 0 \end{pmatrix} + \omega \times \begin{pmatrix} 0 \\ 0 \\ N \end{pmatrix} + (\mathbf{I} \cdot \omega) \times \omega \right) \quad (4)$$

(Clay) pigeon shooting

Whether you want to try shooting for the first time, to improve your marksmanship or simply to enjoy the sport, you will find what you are looking for here. Take part

Home The Club Corporate event

See our clay shooting video here :



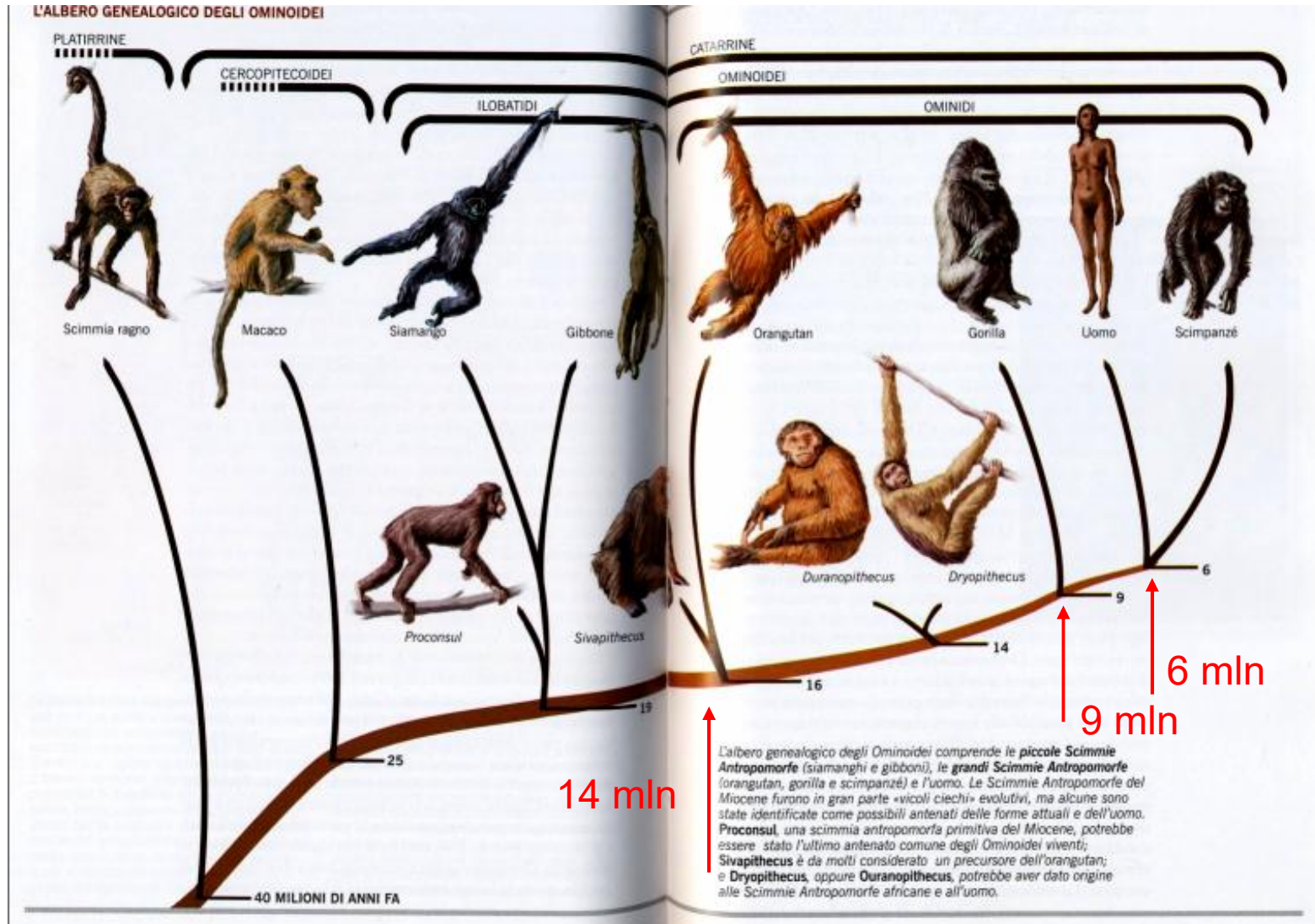
LA ROUE DU ROY DEPUIS 1960

LA ROUE DU ROY

00:55 01:07

<http://www.roueduroy.com/en/take-part-in-activities/clay-pigeon-shooting/>

Czy człowiek pochodzi od małpy?



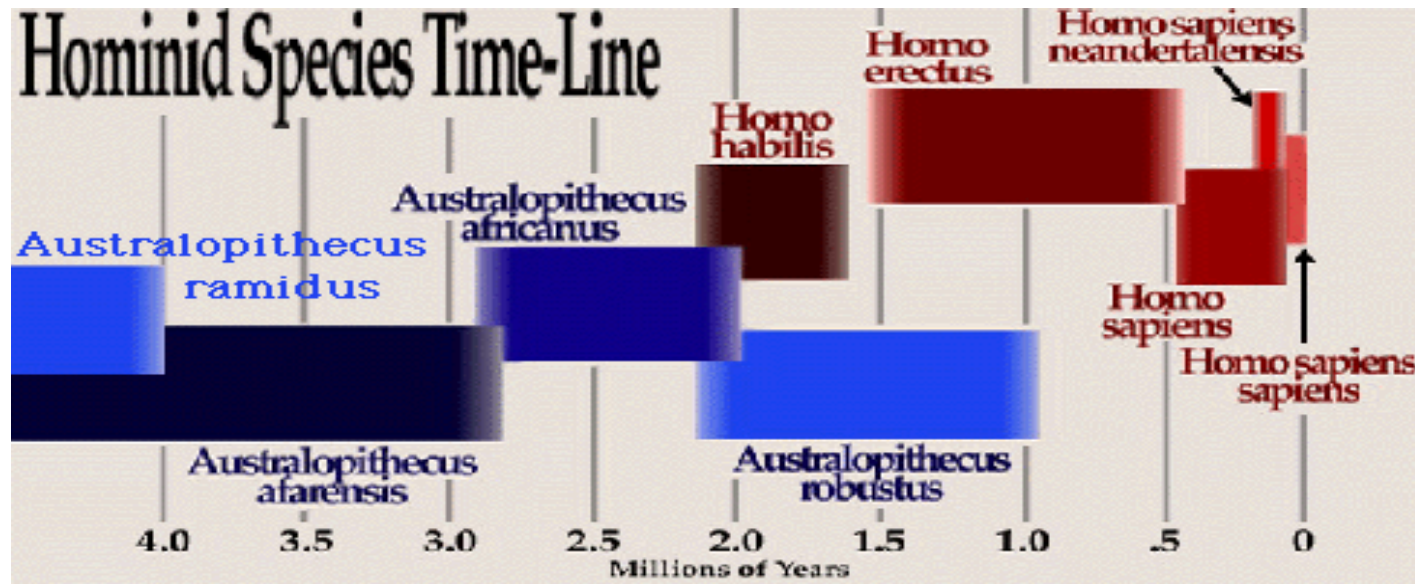
Podobieństwo genetyczne?

- Człowiek/ szympan: złożone funkcje poznawcze, dwunożność, złożony język
- PRZYKŁAD: chromosom 22 szympana: 33,3 miliony zasad nukleinowych vs. chromosom 21 człowieka
- 1,44% tego chromosomu zawiera 68 tys. wklejeń lub wycięć: ta ilość zmian jest wystarczająca, aby zmienić większość białek
- Na 231 sekwencji, 83% z nich, włączając niektóre geny o zasadniczym znaczeniu funkcjonalnym, wykazuje różnice sekwencji aminokwasów
- Obecność różnego rozwinięcia niektórych podrodzin *retrotranspozycji* u tych dwóch rodzajów potomków, które wskazują na różny wpływ retrotranspozycji na przebieg ewolucji człowieka i szympana
- Zmiany genotypu po podziale na dwa rodzaje i ich konsekwencje biologiczne wydają się być znacznie bardziej złożone niż początkowo uważano.

Watanabe, H. et al. *DNA sequence and comparative analysis of chimpanzee Chromosome 22*, Nature 429 (2004) 382-438

Cytowane w: S. Gazzaniga, *Human*, str. 50

Kiedy powstał gatunek *Homo*?



Australopithecus ramidus - 5 - 4 milioni di anni fa

Australopithecus afarensis - 4 - 2.7 milioni di anni fa

Australopithecus africanus - 3.0 - 2.0 milioni di anni fa

Australopithecus robustus - 2.2 - 1.0 milioni di anni fa

Homo habilis - 2.2 - 1.6 milioni di anni fa

Homo erectus - 2 - 0.4 milioni di anni fa

Homo sapiens - 400 mila - 200 mila milioni di anni fa

Homo sapiens neanderthalensis - 200 mila - 30 mila milioni di anni fa

Homo sapiens sapiens 130 mila anni fa - fino a ?

Australopithicus afarensis

Pierwsze ślady chodu dwunożnego

Thus far, fossil remains of over **300** individuals of *A. afarensis* have been discovered.

To date, all the remains of this species have been found in the **Hadar** region of Ethiopia, part of the Rift Valley of east Africa. "**Lucy**," the most complete find, was discovered in 1974.

Hominid footprints 3.5 million years old have been found at **Laetoli** in Tanzania.

Scientists estimate that *A. afarensis* lived from approximately 4 million years ago (or earlier) to around **2.7** millions years ago.



Homo erectus (wyprostowany) – 2 mln lat temu



Chłopiec z Turkany:
12- 13 lat,
1.65 mln lat temu



Robert Korzeniowski,
czterokrotny mistrz olimpijski,
trzykrotny mistrz świata
i dwukrotny mistrz Europy

Chód sportowy (15 km/h)

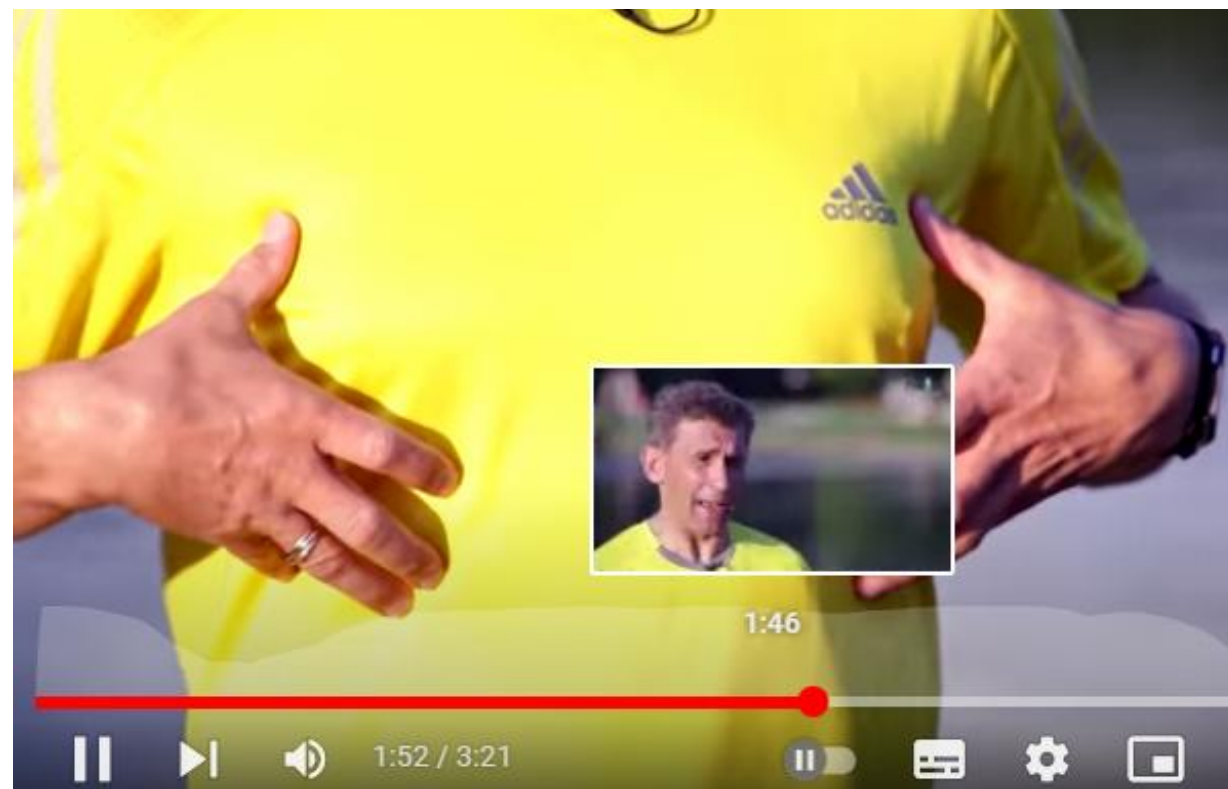


„wykorzystując dynamikę ruchu i całą długość stopy stawiamy ją na pięcie i rolujemy ją do przodu”

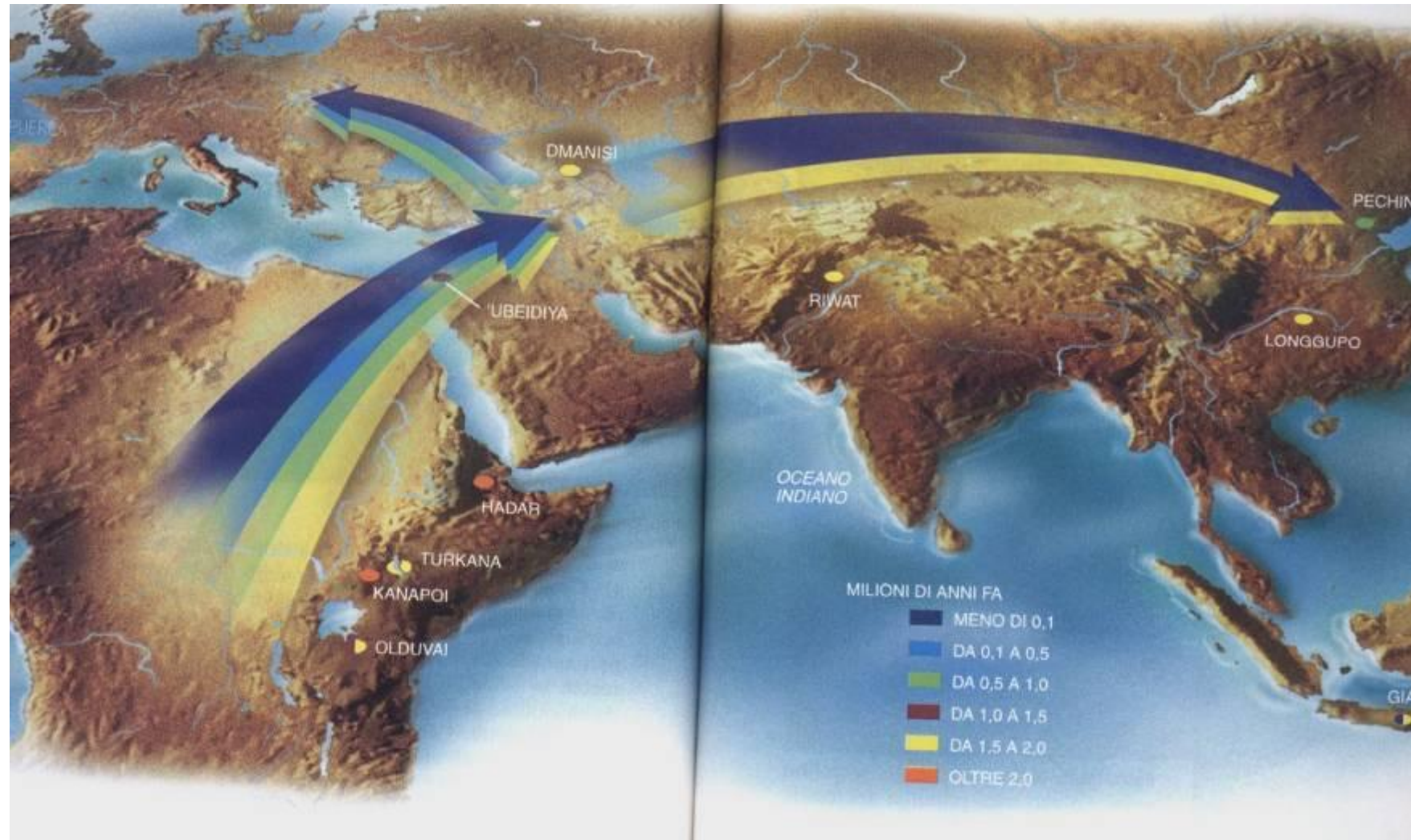


„to jest biomechanika: ruch bioder wynika z ekonomiki ruchu - tak idzie się łatwiej i szybciej”

„pracują wszystkie mięśnie”

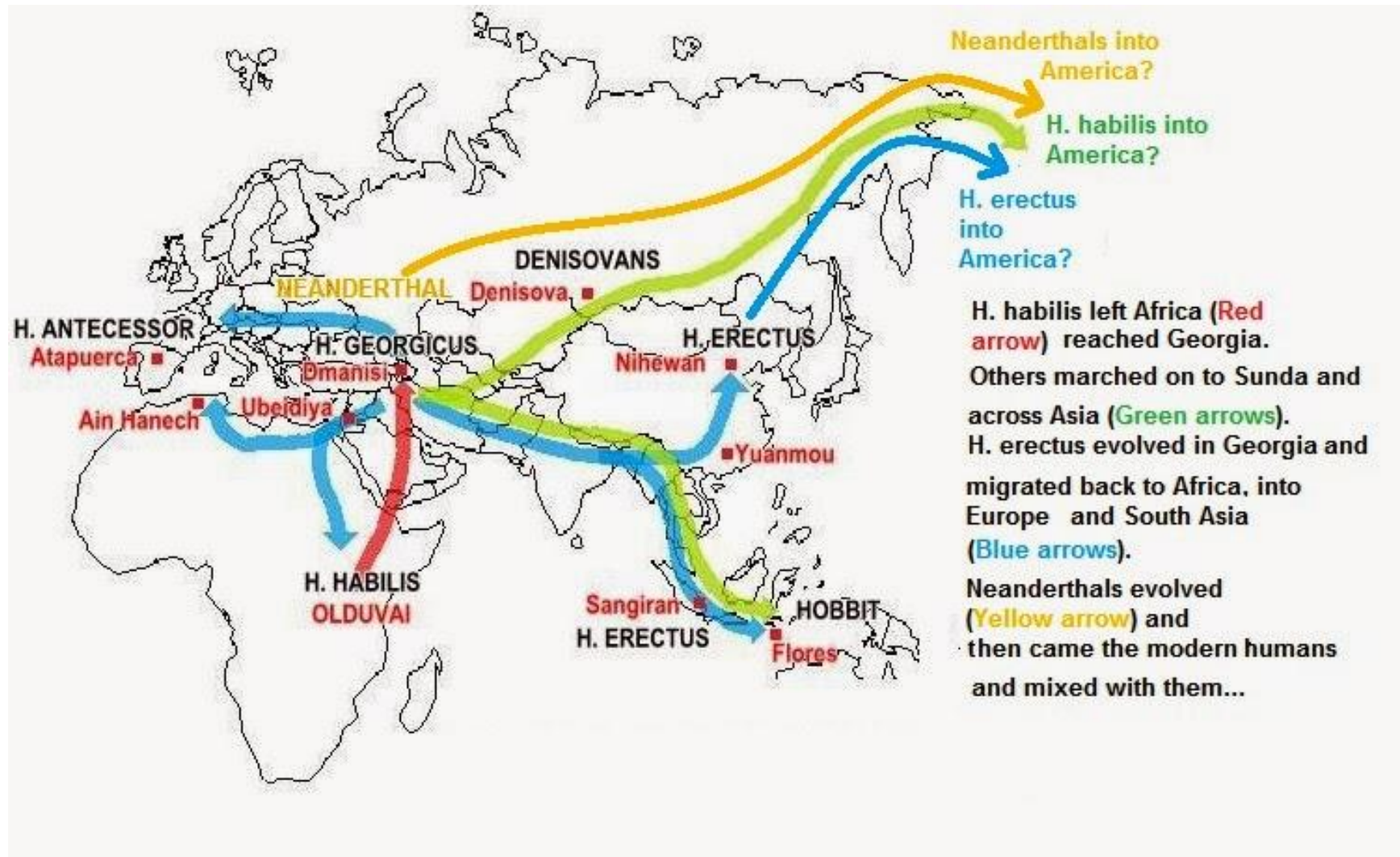


Homo erectus: najznakomitszy wędrowiec w historii Ziemi

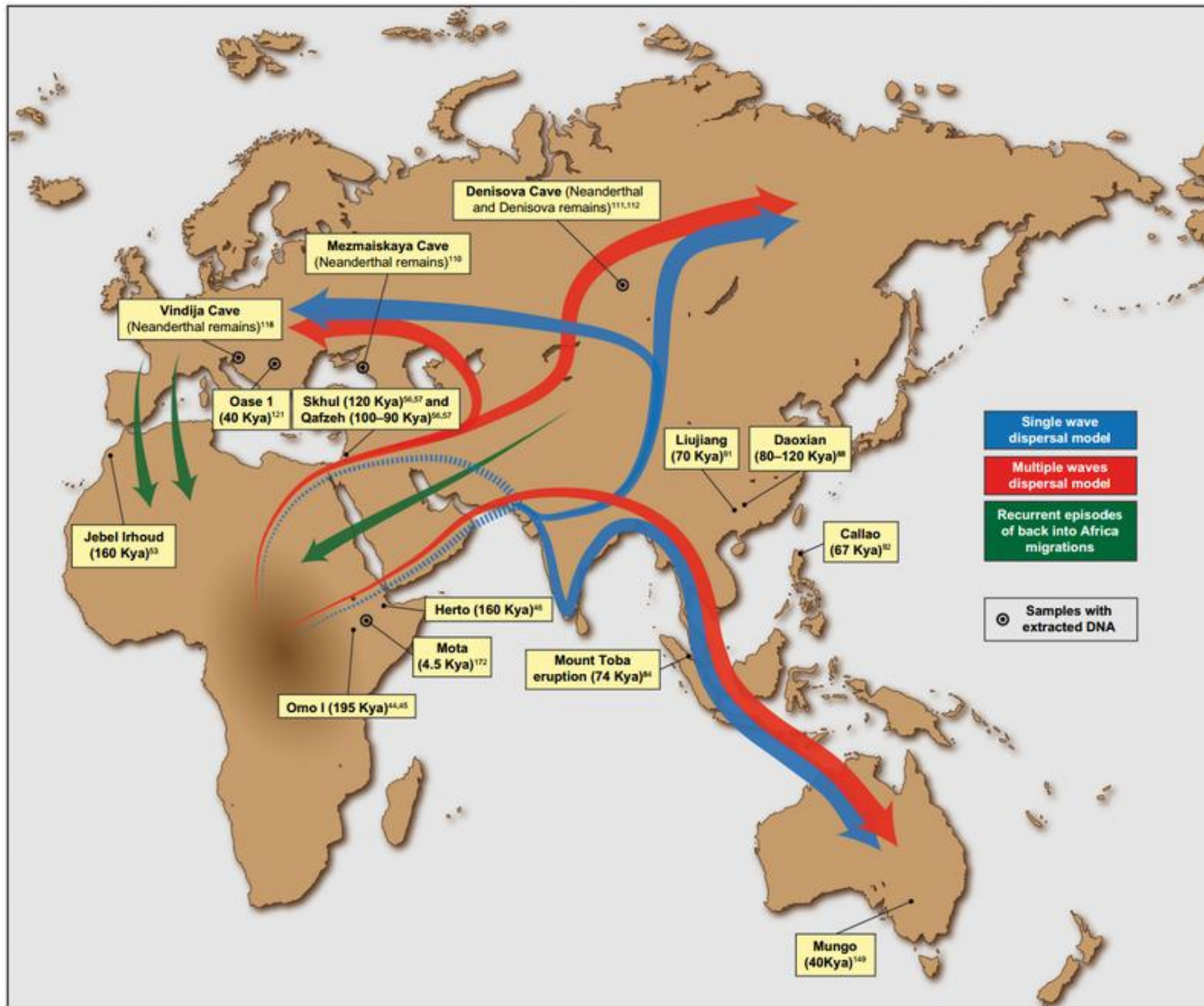


Chiny (*H. pekinensis*, 700 tys. lat temu) na Jawie, w Gruzji (Dmainisi, 2.1 mln lat), Hiszpanii (Gran Dolina), we Włoszech

Turystyka piesza (2 mln lat temu)



Chód sportowy (120 tys. lat temu)



Homo pedonus

Lo scheletro quasi completo di un ragazzo risalente a 1,6 milioni di anni fa fu ritrovato nel lago di Turkana in Tanzania: non era ancora un uomo moderno, anche se perfettamente adatto alla posizione eretta e a lunghe camminate. La sua statura (da adulto) sarebbe di 180 cm. Ma sullo scheletro, simile a quello dell'*Homo sapiens*, era ancora montata la testa dell'ominide, come quella di Lucy.

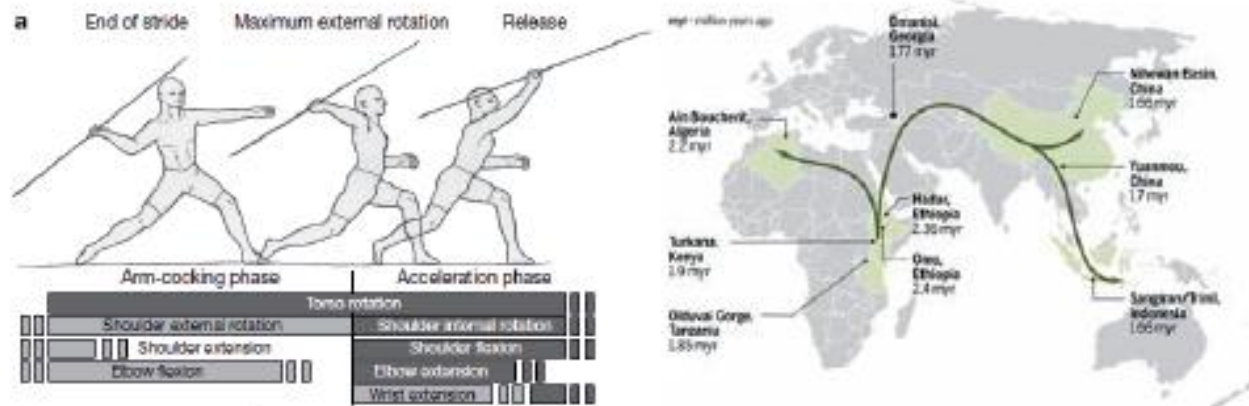


Fig. 6.3. La capacità di caccia delle prime specie dell'*Homo* furono determinate dalla sua fisionomia: un bacino rotabile, la spalla larga e il braccio esteso. b) I siti di ritrovamento di resti delle prime specie dell'*Homo* (*erectus*, *habilis*, *ergaster*) e le vie di migrazione dell'*Homo erectus* fra 1–2 milioni di anni fa. FONTE: «Nature», 498 (2013), pp. 483–486; G. GRULLÓN, «SCIENCE» 354 (2016), p. 958.



Rzut oszczepem (300 tys. lat temu)

1.84 to 2.53 m

The **Schöningen spears** are a set of ten wooden weapons from the Palaeolithic Age that were excavated between 1994 and 1999 from the 'Spear Horizon' in the open-cast lignite mine in Schöningen, Helmstedt district, Germany. They were found together with animal bones and stone and bone tools. [...] between 337,000 and 300,000 years old, placing them at the end of the interglacial Marine Isotope Stage 9



https://en.wikipedia.org/wiki/Sch%C3%B6ningen_spears

Juž starožitni Grecy...



https://en.wikipedia.org/wiki/Hoplite#/media/File:Two_hoplites.jpg

Athletics Javelin throw



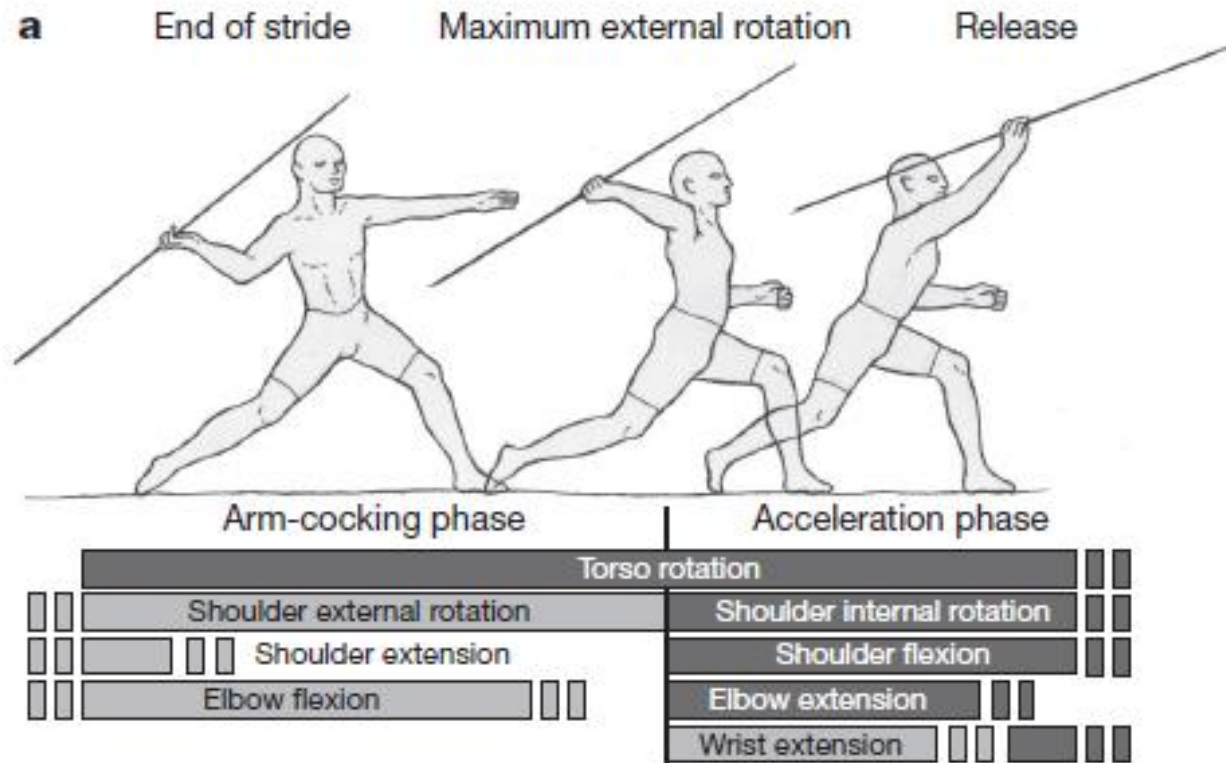
German javelin thrower Thomas Röhler in 2011

World records

Men  Jan Železný 98.48 m (1996)
Women  Barbora Špotáková 72.28 m (2008)

javelin, a spear about 2.5 m

Dlaczego szympansy nie grają w baseball?



N. Roach et al.

Elastic energy storage in the shoulder and the evolution of high-speed throwing in Homo
June 2013

Nature 498(7455):483-486

Mechanika rzutu oszczepem/ piłką

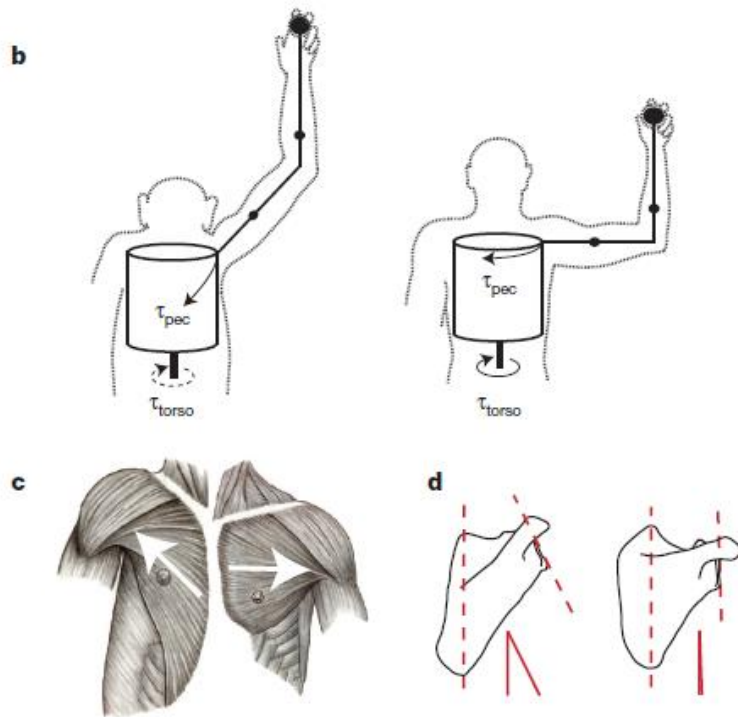


Figure 1 | Model of elastic energy storage. a, Arm-cocking and acceleration phases of the overhand throw. Light grey text boxes show the relative timing of the 'cocking' motions; dark grey boxes indicate the relative occurrence of the opposing 'acceleration' motions. Short boxes illustrate variation in timing of onset and cessation. b, c, Humans (right) and chimpanzees (left) differ in arm abduction and elbow flexion during throwing (b; a free-body diagram shows the torso (cylinder), arm and forearm, with black dots representing segmental centres of mass and τ vectors showing input torques), because of differences in

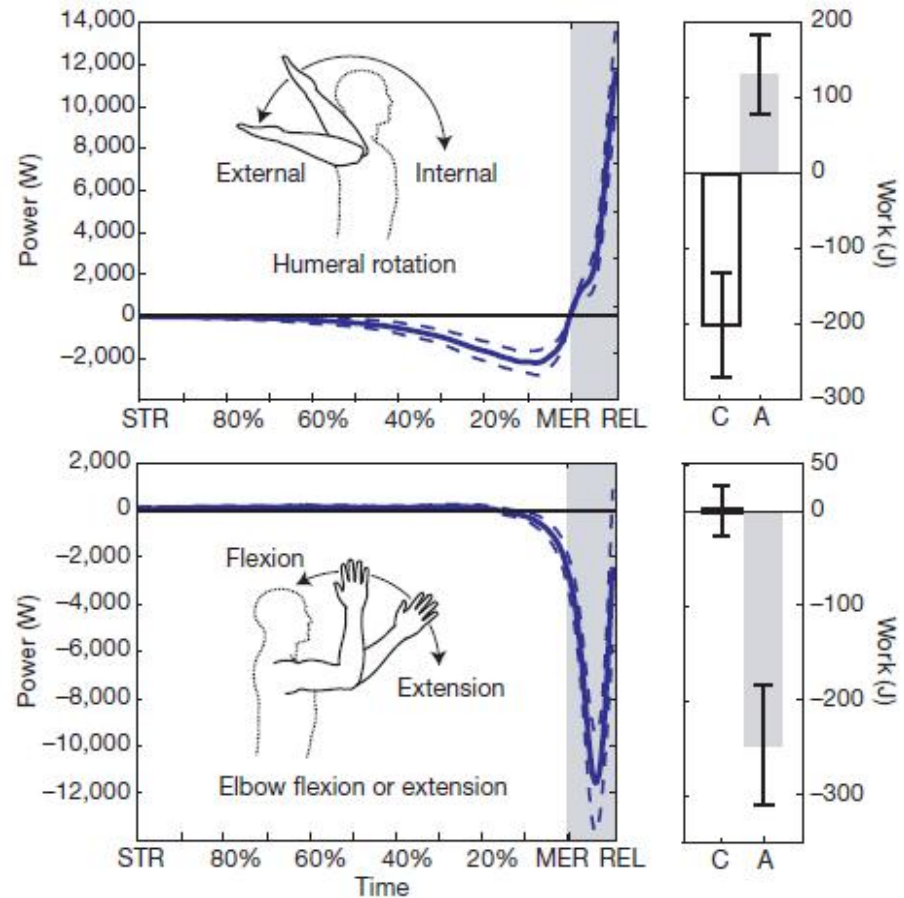


Figure 2 | Shoulder rotation and elbow flexion-extension power. Mean

Throws are powered by rapid, sequential activation of many muscles, starting in the legs and progressing through the hips, torso, shoulder, elbow and wrist. Torques generated at each joint accelerate segmental masses, creating rapid angular movements that accumulate kinetic energy in the projectile until its release. It has been shown that internal (medial) rotation around the long axis of the humerus makes the largest contribution to projectile velocity.

Energia potencjalna sprężystości

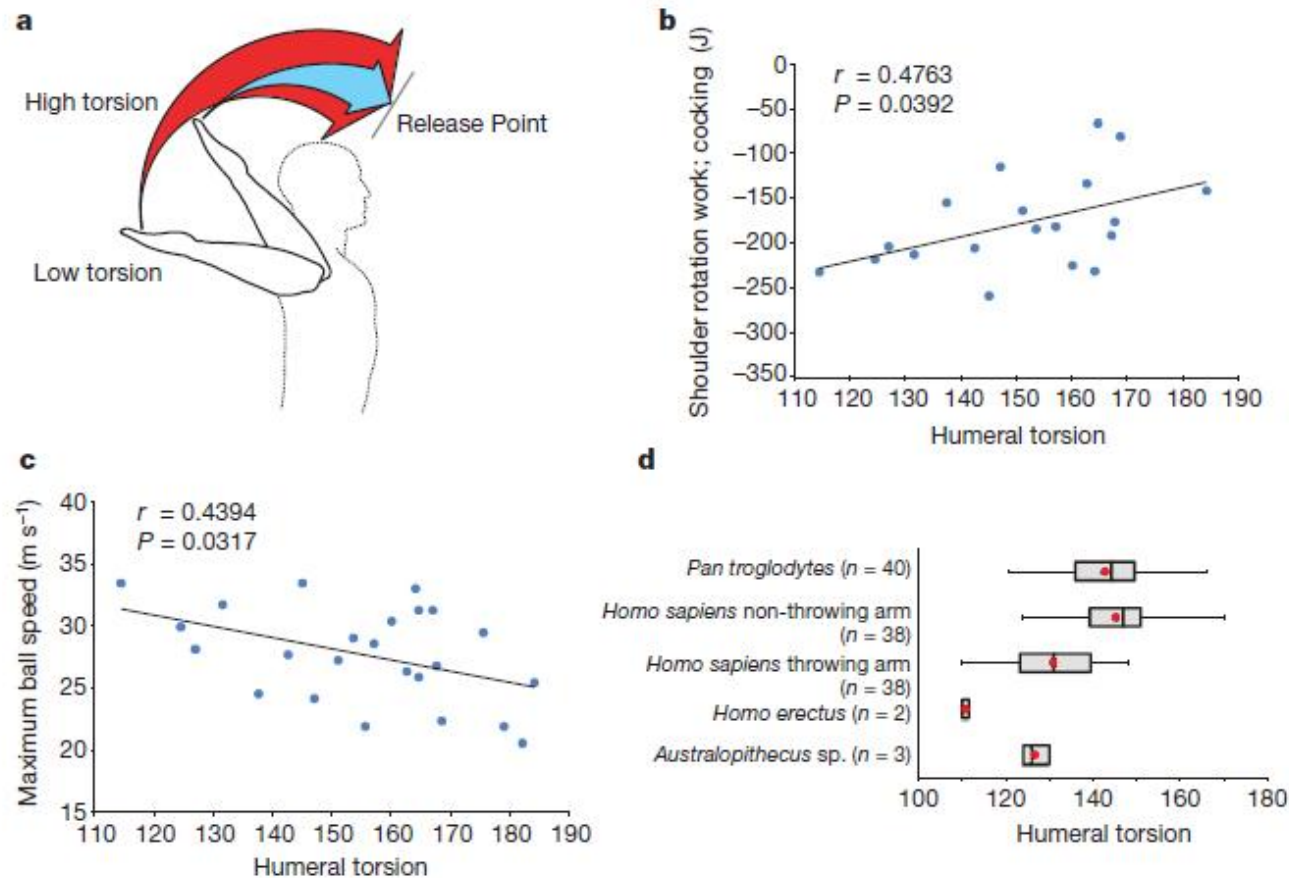


Figure 4 | Humeral torsion and throwing performance. a–c Low humeral torsion shifts the shoulder rotational ROM externally (a), enabling increased negative work during arm-cocking to be stored as elastic energy (b), and resulting in faster projectile speed (c). d, Humans and chimpanzees show comparable degrees of torsion⁵, although throwing athletes show reduced dominant-arm torsion²⁵ consistent with low torsion in *Australopithecus* and

*Homo erectus*⁵. Chimpanzees are a combined sample as they do not show arm dominance, whereas human values are split between dominant and non-dominant arms as they show arm dominance. In d, the black and grey boxes and whiskers show torsion-angle quartiles, and the red dot shows the torsion-angle mean.

Homo erectus sprawniejszy w rzucaniu niż *Homo sapiens*?

Baseball – sport narodowy



<https://www.youtube.com/watch?v=v9GnCkDZS3c>

Dzisiejszy rzut oszczepem

Javelin redesigns [\[edit \]](#)

On 1 April 1986, the men's javelin (800 grams (1.76 lb)) was redesigned by the governing body (the IAAF Technical Committee). They decided to change the rules for javelin design because of the increasingly frequent flat landings and the resulting discussions and protests when these attempts were declared valid or invalid by competition judges. The world record had also crept up to a potentially dangerous level, 104.80 m (343.8 ft) by Uwe Hohn. With throws exceeding 100 meters, it was becoming difficult to safely stage the competition within the confines of a stadium infield. The javelin was redesigned so that the **centre of gravity** was moved 4 cm (1.6 in) forward. In addition, the surface area in front of centre of gravity was reduced, while the surface area behind the centre of gravity was increased. This had an effect similar to that produced by the feathers on an arrow. The javelin turns into the **relative wind**. This relative wind appears to originate from the ground as the javelin descends, thus the javelin turns to face the ground. As the javelin turns into the wind less lift is generated, reducing the flight distance by around 10% but also causing the javelin to stick in the ground more consistently. In 1999, the women's javelin (600 grams (1.32 lb)) was similarly redesigned.^[12]



Uwe Hohn (pictured in 1984) holds the "eternal world record" with a throw of 104.80 m as a new type of javelin was implemented in 1986. ↗

Juž nie kij, ale dzida

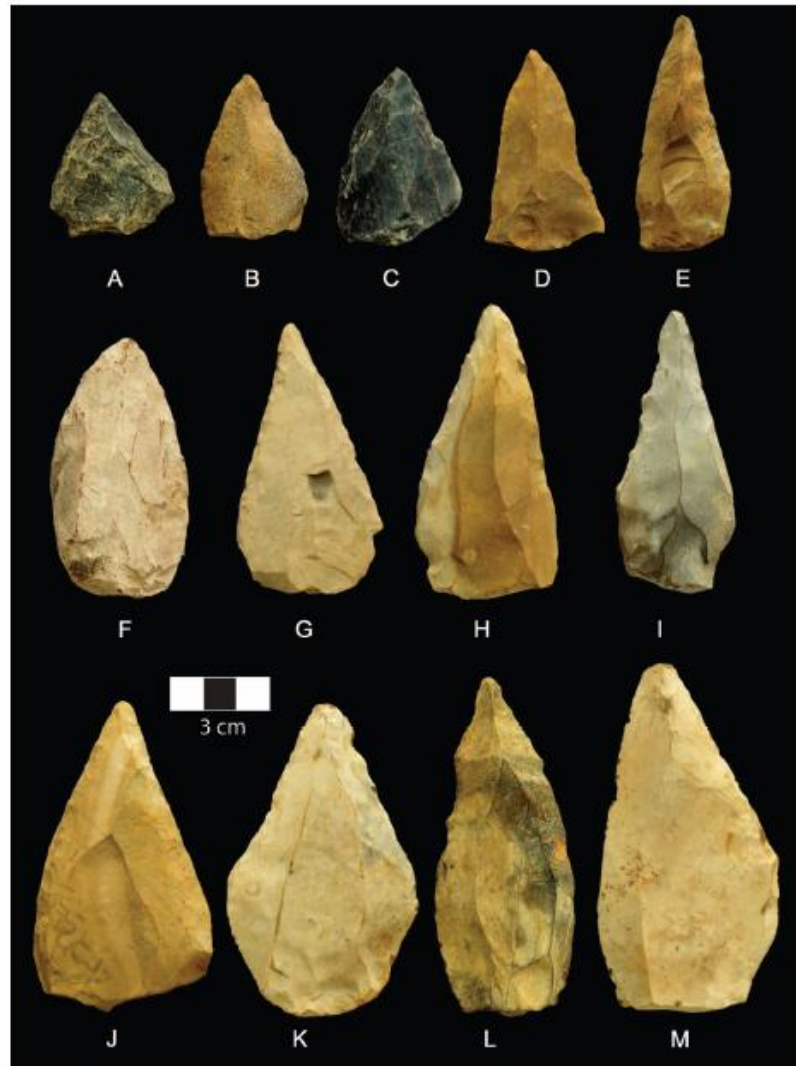


Fig. 1. (A to M) A sample of KP1 complete retouched points. All are banded ironstone except (A) and (C) (black chert). Additional points are presented in figs. S3 and S4.

established weapon tips from Holocene residential sites (Fig. 2E, $\chi^2 = 1.337$, $df = 1$, $P = 0.287$). Impact experiments with similar points made of banded ironstone also exhibit these diagnostic fractures (8/32, 25.0%) (26).

About 13.0% (23/177, excluding distal fragments) of the KP1 points (fig. S5) show evidence of modifications near their bases. Typically, between two and seven flakes were removed from the base of each basal-modified KP1 point. This working could reflect intentional removals to shape the point to allow hafting. The frequency of basal modification is similar to those reported for MSA assemblages with evidence for hafted spear tips (20, 33).

To test the feasibility of KP1 points as spear tips, we reproduced points from the same raw material as most of the KP1 points (banded ironstone) and hafted them onto wooden dowels. We then thrust them into two culled springbok carcasses, using a calibrated crossbow to simulate a thrusting spear and keep force consistent (26). These points performed well and adequately penetrated the target. Most of the 32 replicated points had to be shot multiple times before exhibiting any visible damage, and only two trials resulted in catastrophic damage that prevented the reuse of the points (table S5).

Overall, the sizes of the KP1 points are similar to those of MSA hafted points. The tip cross-sectional perimeter (TCSP) has been used to approximate the size of the wound that would be created by points (17). KP1 points have TCSP values slightly larger than but overlapping with those of MSA points that have been interpreted as spear tips (Fig. 3A). KP1 points are much larger than arrow or dart tips.

Stone tools used for cutting become less symmetrical as one edge is preferentially resharpened; thus, small points are expected to be less symmetrical than large points in an archaeological assemblage of points used mainly as cutting or scraping tools (34). In contrast, spear tips are

**500 tys. lat temu
Ksthu Pan**

Znajomość ognia (1mln lat temu?)

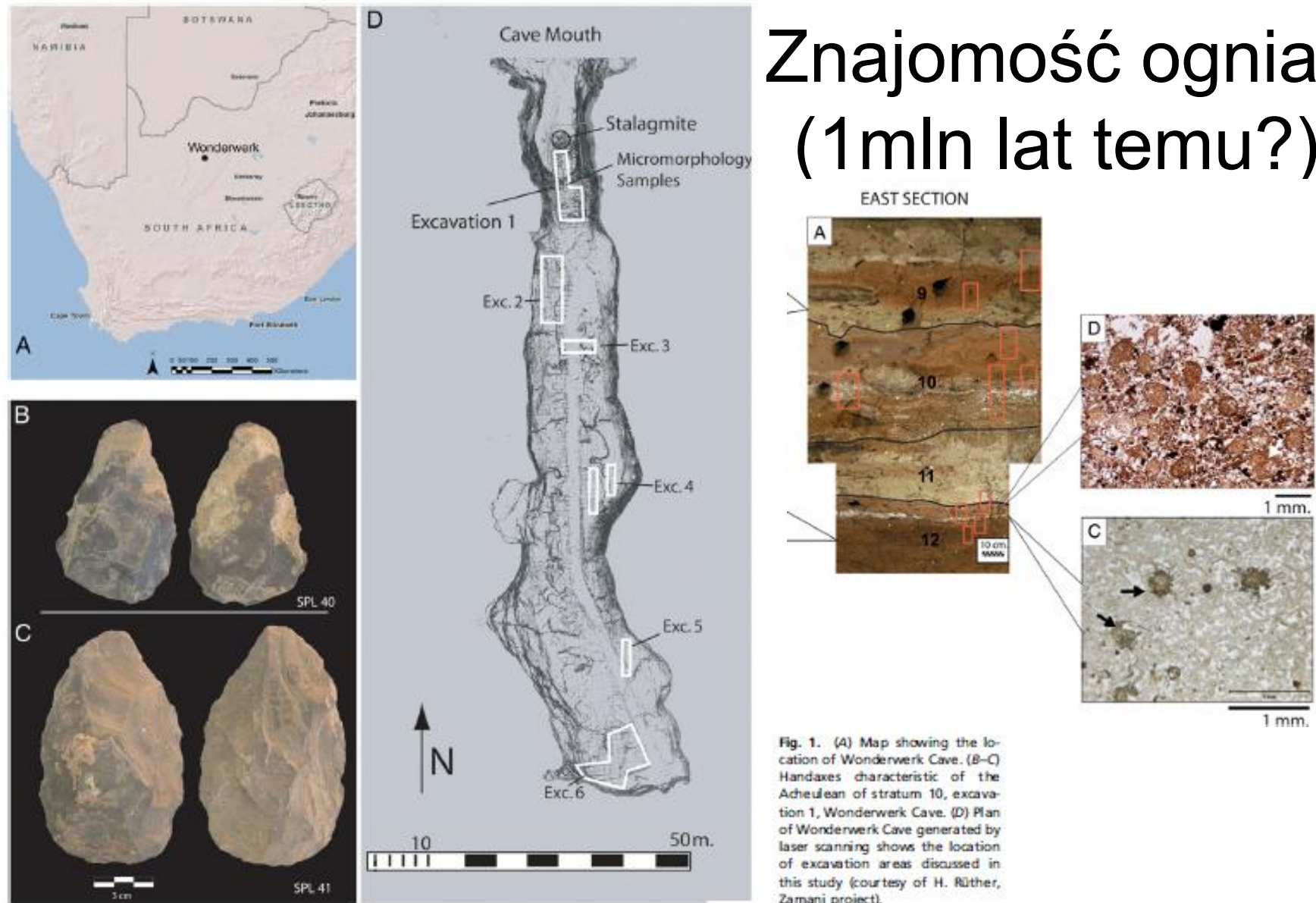
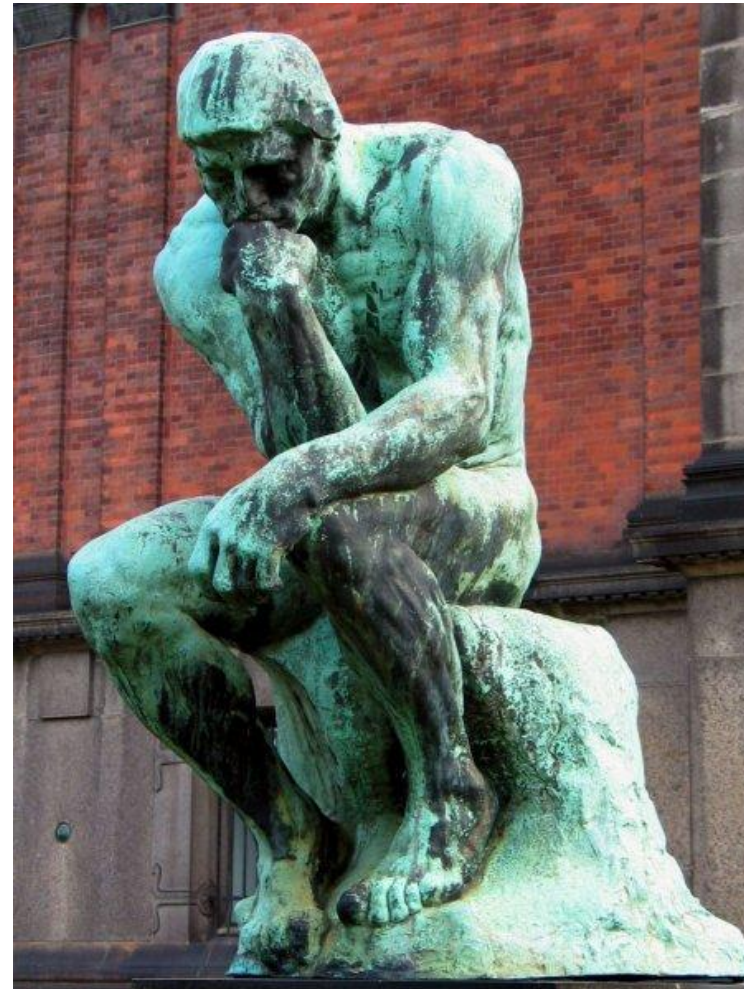


Fig. 1. (A) Map showing the location of Wonderwerk Cave. (B–C) Handaxes characteristic of the Acheulean of stratum 10, excavation 1, Wonderwerk Cave. (D) Plan of Wonderwerk Cave generated by laser scanning shows the location of excavation areas discussed in this study (courtesy of H. Rüter, Zamani project).

Discobolus



Discobolus in National Roman Museum Palazzo Massimo alle Terme
<https://cultura.biografieonline.it/auguste-rodin-il-pensatore/>

Pchnięcie kulą, rzut młotem



m=7.26 kg, rekord 23.37 m



m=7.26 kg (4 kg), rekord 86.7 m (82.98 m)

<https://sites.google.com/site/lekkoatletykarunning/rzuty/pchniecie-kula>

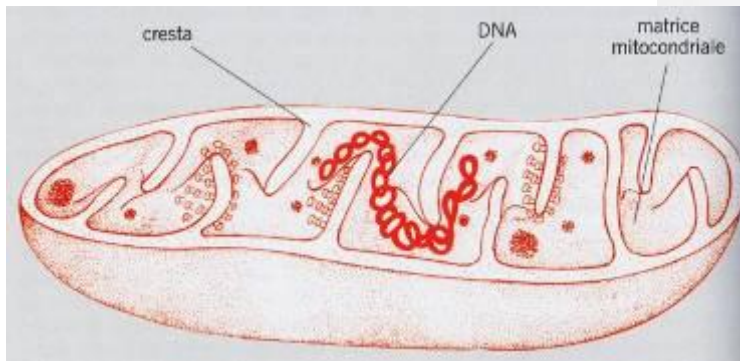
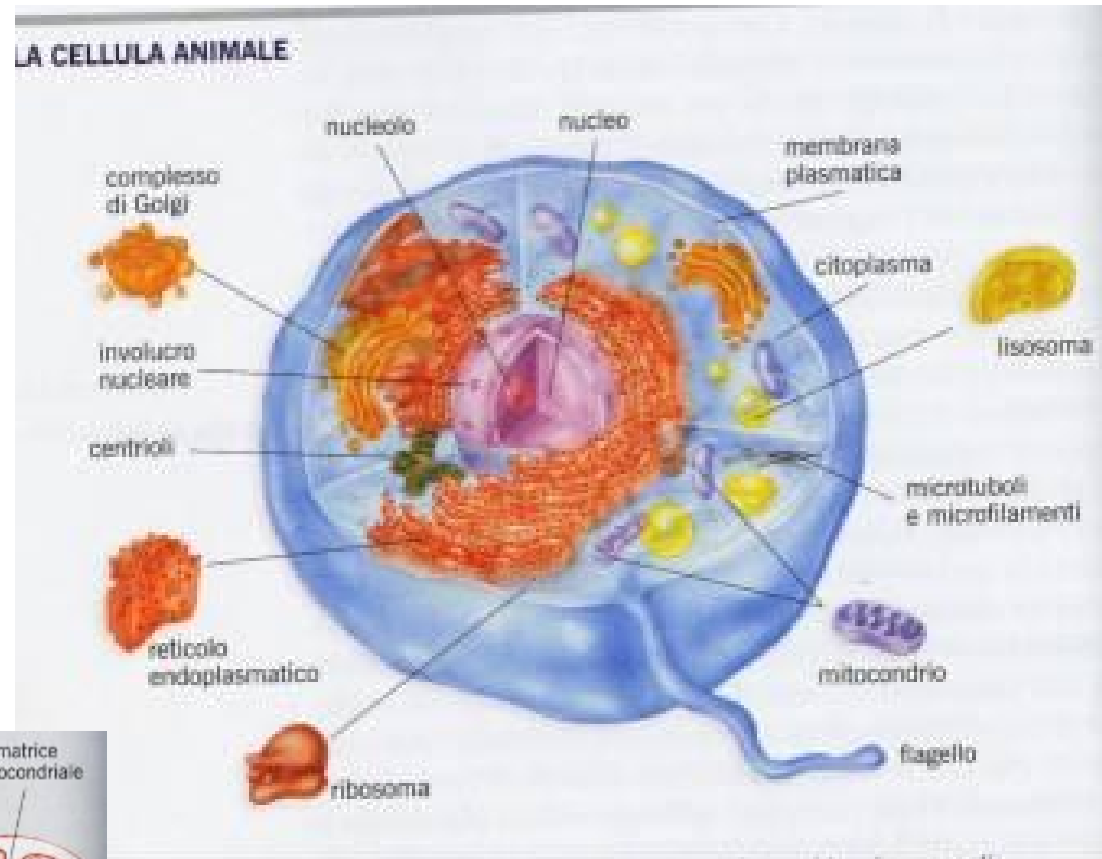
<https://sport.interia.pl/aktualnosci-sportowe/news-rzut-mlotem-konkurencja-nielubiana-przez-iaaf,nId,582694>

Genom człowiek/ szympanas

- „Badania porównawcze genomu szympanasa i człowieka mają zasadnicze znaczenie dla zdefiniowania zmian genetycznych, które doprowadziły do zdobycia typowych charakterystyk człowieka, jak wysoko rozwinięte funkcje poznawcze, dwunożność czy używanie złożonego języka. W niniejszej pracy przedstawiamy podsumowanie wysokiej jakości sekwencjonowania DNA z 33,3 Mega-zasadami chromosomu 22 szympanasa. Porównując całość sekwencji z odpowiednim chromosomem człowieka, 21, odkryliśmy, że 1,44% chromosomu zawiera 68.000 zmian pojedynczej nukleo-zasady, wstawień lub wycięć.
- Te różnice są wystarczające, aby wywołać zmiany w większości syntetyzowanych białek. I tak, na 231 sekwencji, 83%, w tym włączając niektóre geny funkcjonalnie istotne, zawiera różnice na poziomie sekwencji aminokwasów.
- Ponadto odkryliśmy różnice w rozwinięciu w niektórych podrodzinach retro-transpozycji w dwóch rzędach potomnych, które sugerują różny wpływ retro-transpozycji na ewolucję człowieka i szympanasa.
- Zmiany genomu po rozdziale gatunków i ich konsekwencje biologiczne wydają się znacznie bardziej złożone niż to wcześniej przypuszczano.”

Watanabe et al. *DNA sequencing and comparative analysis of chimpanzee Chromosome 22*, Nature, 429 (2004) 382 [trad.z włoskiego GK]

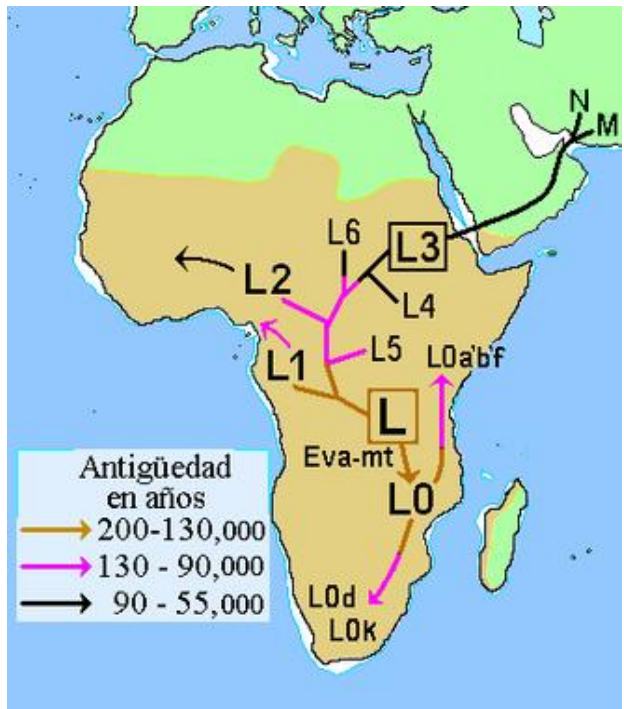
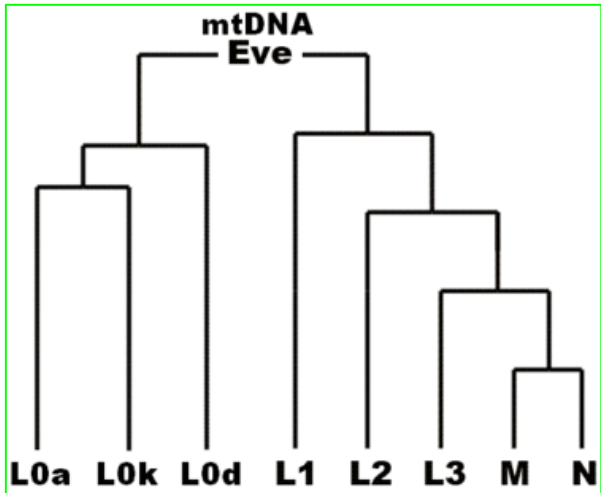
DNA mitocondriale



Orologio dell'evoluzione di Homo sapiens

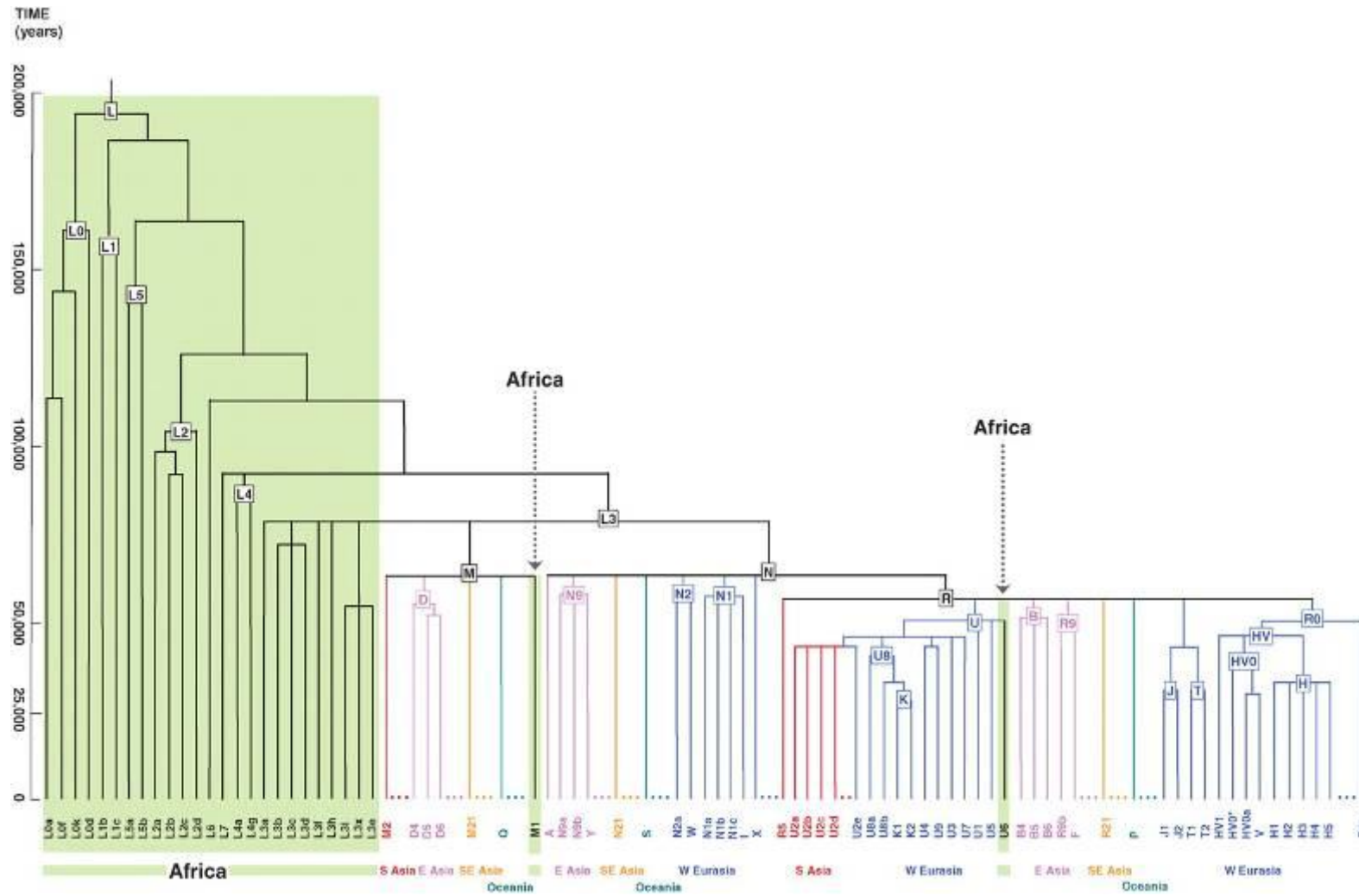
11- 12 mutazioni

Eve mitochondrial



Lucas Cranach

Fig. 1. Schematic representation of the worldwide phylogeny of human mtDNA.



A Olivieri et al. Science 2006;314:1767-1770



Badania populacji lokalnych

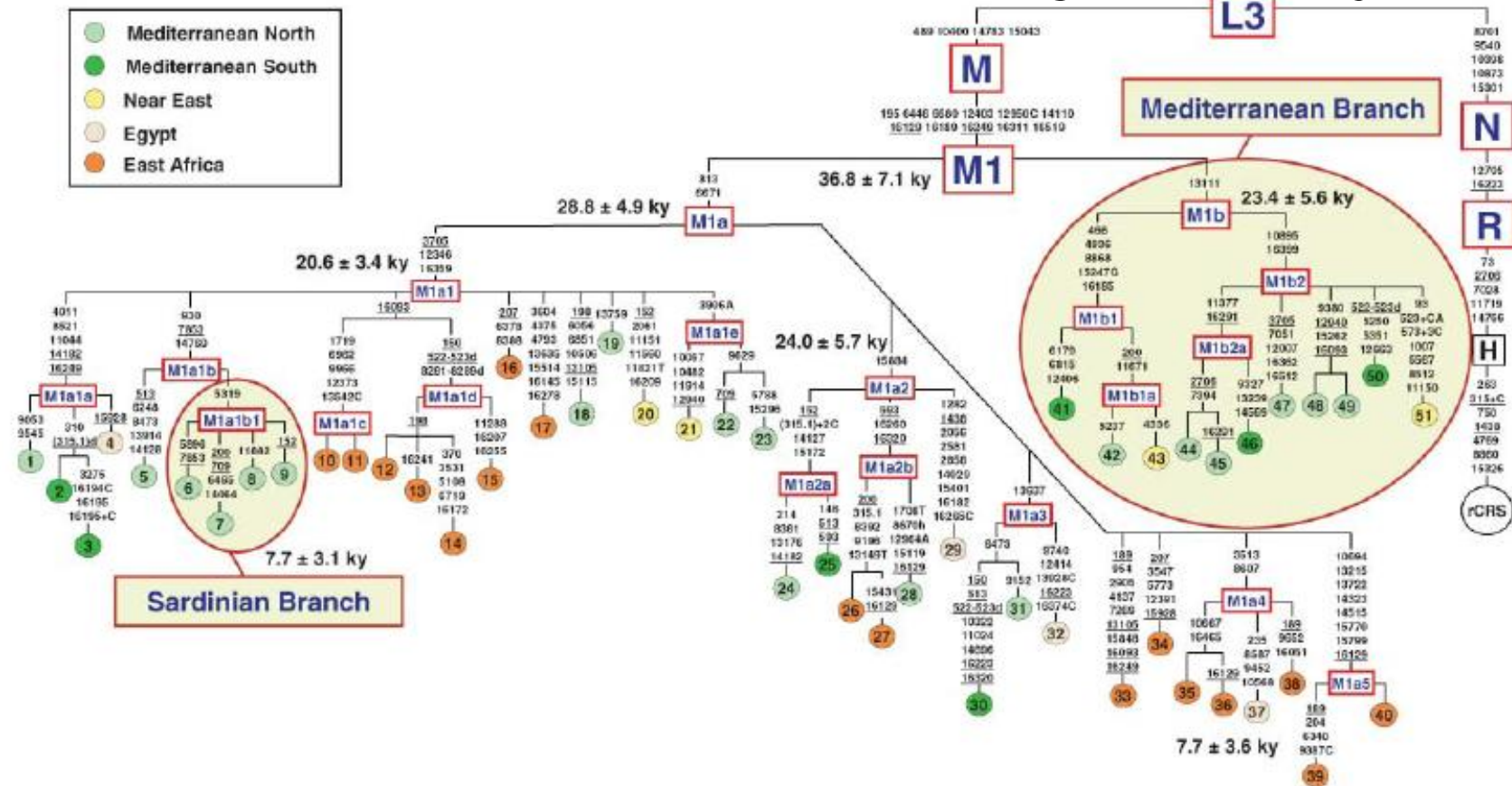


Fig. 2. Tree of 51 mtDNA sequences belonging to haplogroup M1. The tree is rooted using the reference sequence (rCRS) (27) as an outgroup. The sequencing procedure and phylogeny construction were performed as described elsewhere (4, 28, 29). mtDNAs were selected through a preliminary sequence analysis of the control region and a restriction fragment length polymorphism survey in order to include the widest possible range of internal variation of the haplogroup. All M1 sequences are new except for 17, which is the same sample as 25 in Torrioni *et al.* (3). Mutations are shown on the branches; they are transitions unless a base is explicitly indicated. Suffixes indicate transversions (to A, G, C, or T), indels (+, d) or

heteroplasmy (h). Recurrent mutations are underlined; pathological mutations are in italics. The ethnic or geographic origins of mtDNAs are as follows: Italy (1, 5 to 9, 23, 24, 28, 31, 42, 44, 45, and 47 to 49); Berbers of Egypt (2 and 3); Egypt (4, 29, 32, and 37); Ethiopian Jews (10 and 11); Ethiopia (12 to 17, 26, 27, 33 to 35, 38, and 40); Greece (18 and 19); Iraqi Jew (20); Druze (21); American (USA) of European ancestry (22); Berbers of Morocco (25, 30, 46, and 50); Kenya (36); Somalia (39); Mauritania (41); Bedouin, southern Israel (43); and Iraqi (51). For additional information regarding the tree, see the supporting online material (SOM).

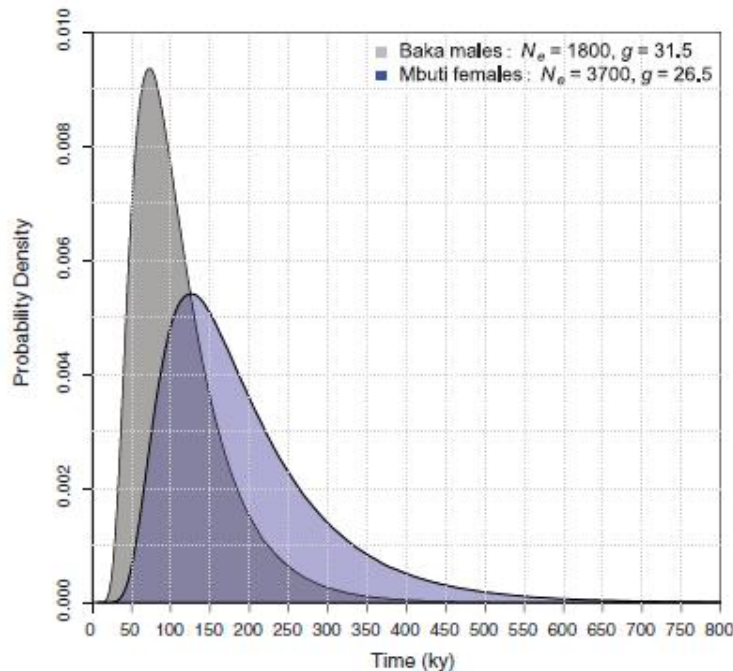
Table 1. T_{MRCA} and N_e estimates for the Y chromosome and mtDNA. Pop., population.

Method	Y chromosome				mtDNA			
	Pop.	n	T_{MRCA}^*	N_e	Pop.	n	T_{MRCA}^*	N_e
Molecular clock	All	69	139 (120–156)	4500 [†]	All	93	124 (99–148)	9500 [†]
GENETREE [‡]	San	6	128 (112–146)	3800	Nzebi	18	105 (91–119)	11,500
	Baka	11	122 (106–137)	1800	Mbuti	6	121 (100–143)	3700

*Employs mutation rate estimated from within-human calibration point. Times measured in ky. †Uses Watterson's estimator, $\hat{\theta}_w$. ‡Each coalescent analysis restricted to a single population spanning the ancestral root (11).

m-DNA vs. Y-DNA

Fig. 3. Similarity of T_{MRCA} does not imply equivalent N_e of males and females. The T_{MRCA} for a given locus is drawn from a predata (i.e., prior) distribution that is a function of N_e , generation time, sample size, and demographic history. Consider the distribution of possible T_{MRCA} s for a set of 100 uniparental chromosomes. Although the Mbuti mtDNA N_e is twice as large as that of the Baka Y chromosome, the corresponding predata T_{MRCA} distributions overlap considerably.



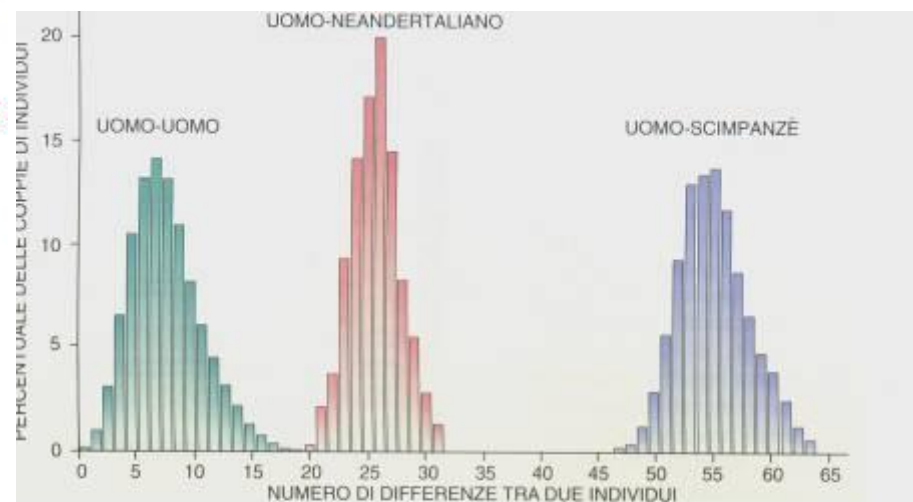
The Y chromosome and the mitochondrial genome have been used to estimate when the common patrilineal and matrilineal ancestors of humans lived. We sequenced the genomes of 69 males from nine populations, including two in which we find basal branches of the Y-chromosome tree. We identify ancient phylogenetic structure within African haplogroups and resolve a long-standing ambiguity deep within the tree. Applying equivalent methodologies to the Y chromosome and the mitochondrial genome, we estimate the time to the most recent common ancestor (T_{MRCA}) of the Y chromosome to be 120 to 156 thousand years and the mitochondrial genome T_{MRCA} to be 99 to 148 thousand years. Our findings suggest that, contrary to previous claims, male lineages do not coalesce significantly more recently than female lineages.

Neandertaler: nasz brat?



Neandertaler: mózg 1340-1520 cm³
(Homo sapiens 1300 cm³)
Malował ciało, chował zmarłych

DNA mitochondriale



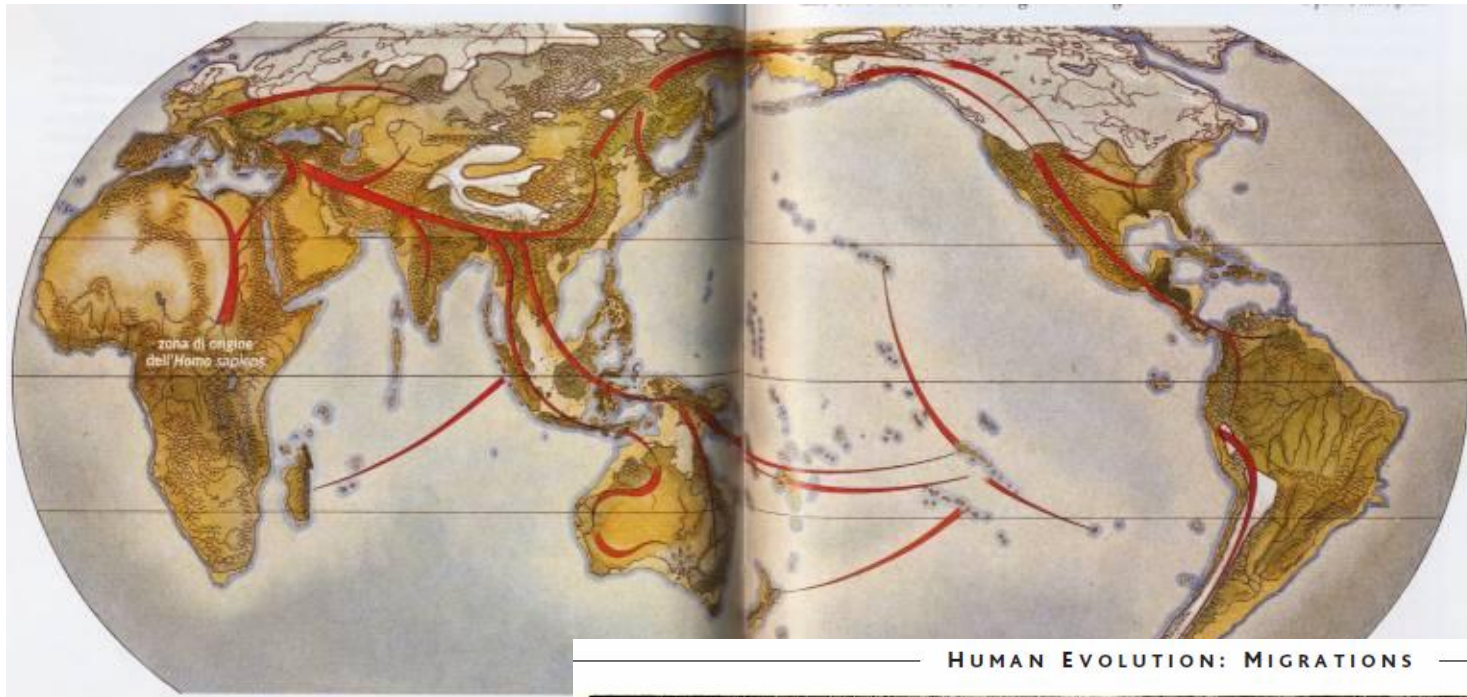
Un frammento di DNA mitocondriale dell'uomo di Neandertal è stato sequenziato, poi confrontato con quello del frammento analogo di uomini moderni (in rosso). Le differenze delle sequenze sono più numerose tra questo neandertaliano e gli uomini moderni (26) di quanto non siano tra i soli uomini moderni (8), ma più rare che tra gli uomini moderni e gli scimpanzé (55). Tuttavia, tra gli uomini e il neandertaliano esiste una zona di sovrapposizione degli intervalli di variazione (circa 20 sostituzioni): certi uomini moderni potrebbero quindi essere più affini ai neandertaliani che non agli altri uomini moderni.

NIE!

Homo sapiens: 40 tys. lat temu



Homo sapiens: 10 tys. lat temu



HUMAN EVOLUTION: MIGRATIONS

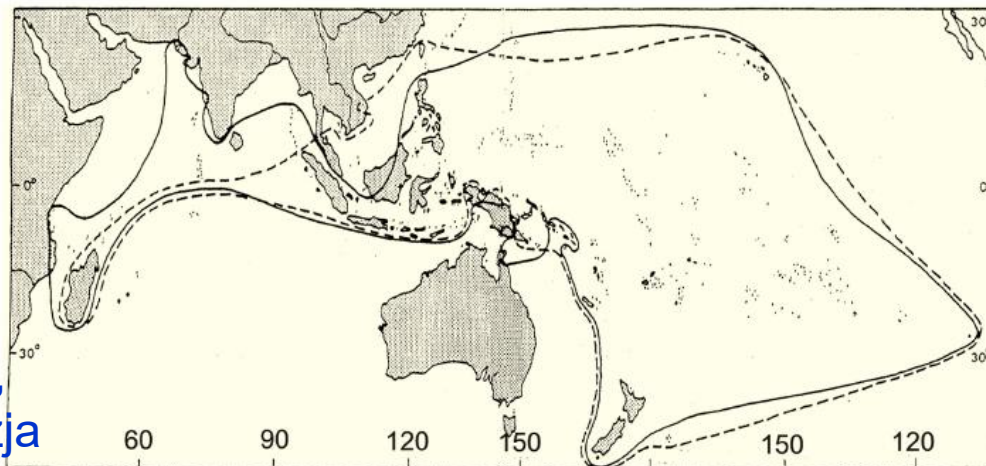


Fig. 2. Map showing the correlation between the Austronesian language family and the use of outrigger canoes [modified from Roger Green's essay on the Lapita cultural complex (57)]. The dashed line shows the distribution of Austronesian languages, and the solid line shows the distribution of outrigger canoes.

Ameryka (Clovis, 11kys BP),
Oceania, Polinezja, Mikronezja
ponownie Australia (psy dingo)

R. L. Cann, Science, 2/03/2001

Homo Sapiens: rytuały pogrzebowe, Sztuka



Rosja
Don River: Kostenki



Lascoux
25.000-14.000



„Una Terra per l’Uomo”

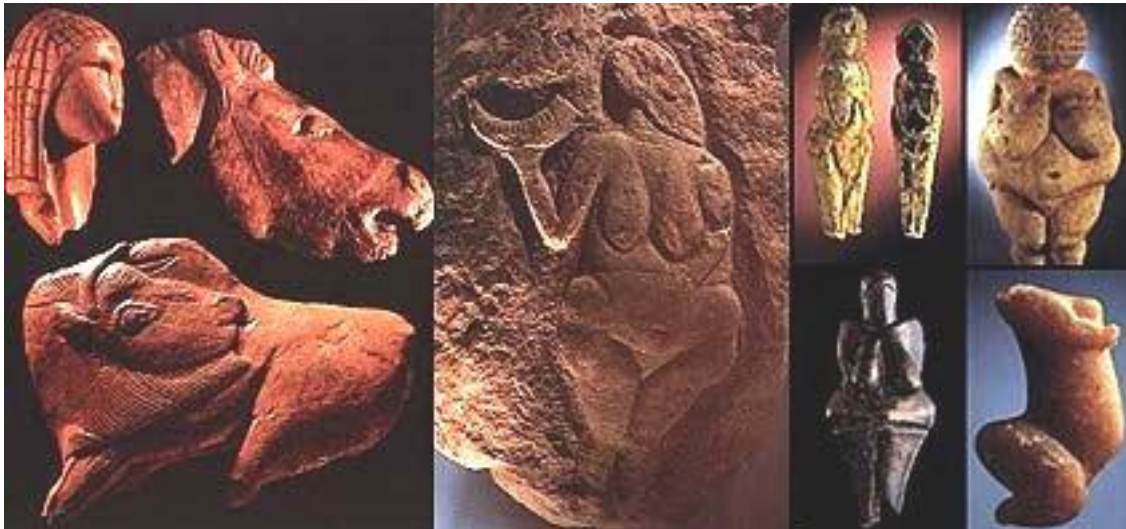
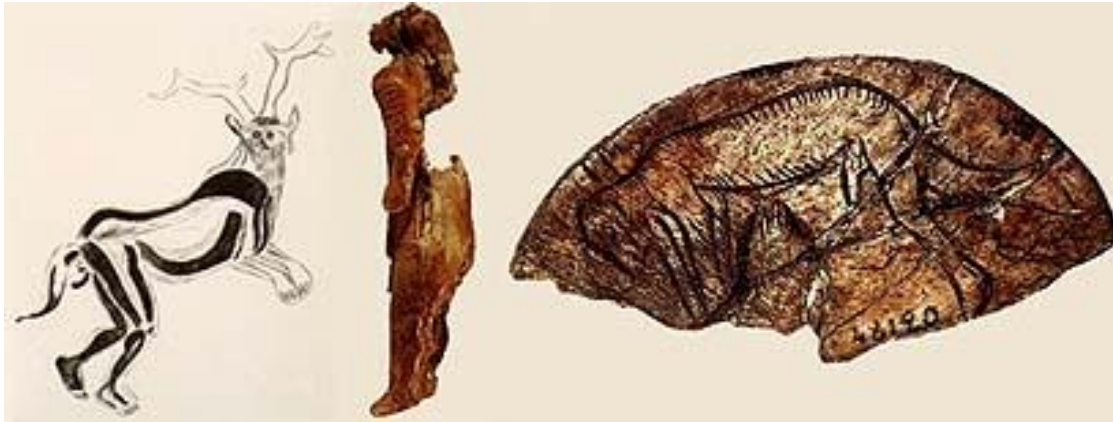
Homo Sapiens: sztuka abstrakcyjna



„Una Terra per l’Uomo”

Homo Sapiens: mitologia

29.000-25.000 BC



https://fr.wikipedia.org/wiki/Doln%C3%AD_V%C4%9Bstonice

Muzyka Magdaleńska (17-12 tys. lat temu)

Les premiers artisans du monde

L'ivoire de mammoth a servi de matériau noble aux chasseurs qui pouvaient se le procurer, quand le puissant animal parcourait leurs paysages et peut-être aussi leur imaginaire comme en témoignent figurines et représentations pariétales. La parure aurignacienne (d'Aurignac, en Haute-Garonne), trouvée en abondance dans de nombreux habitats de l'est à l'ouest de l'Europe, compte de grandes quantités de perles en ivoire. Certaines (à l'abri Blanchard en Dordogne, par exemple) ont été obtenues en série par une technique particulière de découpe de la baguette débitée dans l'ivoire, puis de perforation ayant permis de les calibrer avec précision. Plus tardive, la parure gravettienne en ivoire n'est pas moins exceptionnelle de finesse et de technicité, en particulier sous les doigts habiles des Pavloviens de Moravie ou des Kostienkiens (qui sont les Gravettiens de l'Europe orientale) de Russie et d'Ukraine : des bagues dont l'épaisseur n'excède pas un millimètre, des diadèmes ornements de motifs incisés, des bracelets taillés dans la masse pour conserver leur enroulement naturel.

Les dents de cervidés – en particulier les crâches de rennes et de cerfs –, de bovinés, d'équidés, et électivement de carnivores – des canines de félins, ours, loups, renards –, furent très fréquemment perforées pour être enfilées et portées en pendeloques ou en colliers par les vivants et par les morts dans les sépultures.

Les ossements, minces ou épais, longs ou larges, furent abondamment utilisés pour élaborer une belle panoplie d'outils, d'instruments, d'objets. Dans des

Les dents d'animaux chassés ont été abondamment utilisées par les Préhistoriques pour confectionner une partie de leurs parures, en particulier les pendeloques. La perforation est généralement pratiquée dans la racine, plus tendre, surtout pour les canines de carnivores. La présence de crocs d'animaux dangereux (à gauche), chassés sans doute pour leurs peaux et non pour leur consommation, est importante dans la symbolique des parures corporelles des vivants comme des morts qui furent ensevelis avec elles. Les représentations pariétales et mobilières (statuettes, outils, armes), à l'inverse, laissent peu de place aux carnivores, sans que le bestiaire essentiellement composé d'herbivores soit le reflet de la faune effectivement chassée. En revanche, les rondelles découpées par des Magdaléniens dans des omoplates de rennes (à droite), puis perforées sont ornées de figures animales et de motifs géométriques comparables aux représentations mobilières.



omoplates de rennes, les Magdaléniens des Pyrénées et d'Aquitaine ont découpé des rondelles, ensuite perforées (peut-être pour être portées en parure ou cousues sur des vêtements) et souvent incisées de motifs abstraits, géométriques ou figuratifs. Des côtes d'herbivores étaient souvent transformées en lissoirs, couteaux, pelles, par simple abrasion de leurs bords ou affûtage de leurs extrémités. Des poignards et des manches étaient taillés dans des diaphyses d'os longs et résistants, des flûtes et des appeaux dans des os cylindriques et creux d'oiseaux.

Le sacre du chasseur

Les immenses troupeaux de rennes qui ont sillonné l'Europe, sauf dans ses extrémités péninsulaires méridionales, pendant la quasi-totalité du Paléolithique supérieur, ont fourni aux chasseurs un stock vivant, inépuisable et facilement accessible de réserves carnées et de matériaux pour la fabrication d'outils, d'armes et de pièces ornementales de petites dimensions. L'exploitation des ramures – des mâles

Des traces de percussion sur des omoplates de mammoths en Europe orientale, d'autres sur les draperies et concrétions dans des grottes ornées en Europe occidentale, ainsi que des appeaux et quelques flûtes taillées dans des diaphyses cylindriques d'os témoignent de l'existence de pratiques musicales au Magdalénien. Des répliques de ces instruments testées dans des grottes ornées ont permis de simuler des sons magdaléniens. Ci-dessous, une flûte magdalénienne.



Cofając się jeszcze dalej...

92 «SAPIENS SAPIENS», LE QUINQUÉNIEN

rapport à celles des Néandertaliens (moustériennes et châtelperroniennes). Certes, des caractères d'acculturations sont décelables dans les premiers ensembles industriels aurignaciens de l'Europe centrale et orientale, comme s'il y avait eu influence ou assimilation de traits culturels et techniques moustériens préexistants. Mais les fouilles conduites en France et en Espagne dans des habitats de Châtelperroniens (les derniers Néandertaliens connus en Europe atlantique) et dans ceux beaucoup plus nombreux des nouveaux venus Aurignaciens, qui furent vraisemblablement un temps leurs voisins avant de prendre définitivement leur place, mettent en évidence des différences fondamentales. Là, aucun échange culturel, aucune influence ne se décèlent entre les ensembles industriels et culturels des anciens, les Néandertaliens châtelperroniens encore fortement marqués par la culture moustérienne, et les modernes avec leurs nouveaux outils, leur mode perfectionné de débitage, leurs instruments de chasse plus efficaces, leur façon de vivre révolutionnaire et leurs premières représentations figuratives dans certains de leurs habitats, du côté de la Vézère; de l'Ardèche et en Allemagne aussi.

Deux humanités face à face

Rien ne permet de qualifier de belliqueuse ou de pacifique cette coexistence multimillénaire, en

L'habitat aurignacien du Vogelherd en Allemagne (page de droite) a livré dans ses sols datés nettement au-delà de 30 000 ans une admirable série d'une dizaine de figurines animales en ivoire : cheval, félin, bison, mammoth (jéde-sous). La stylistique de cette statuette, peut-être la plus ancienne connue, montre le haut niveau technique et esthétique atteint par les Aurignaciens,



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une quinzaine de milliers d'années avant les Magdaléniens de Lascaux. D'entrée, l'art mobilier rassemble les caractères propres à l'art paléolithique.

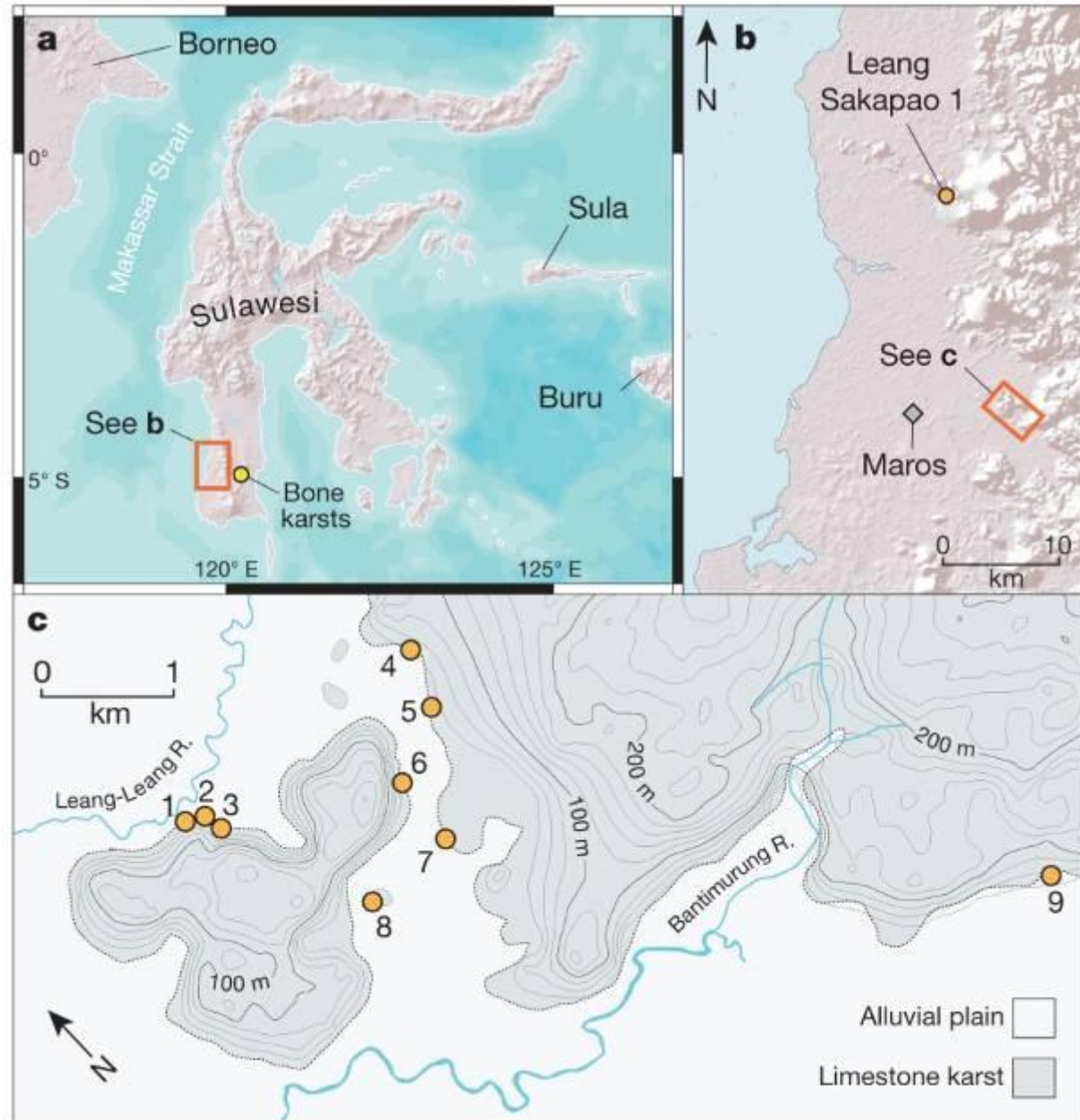
le Proche-Orient? Leur patrimoine différencié de celui hérité par d nouveaux immigrants européens rapprochement entre eux, com Il est troublant d'imaginer ces pratiquement face à face, scus pas si longtemps! Certes notre plus facilement vers l'Évolué, ancêtre! Mais l'autre? Lui auss

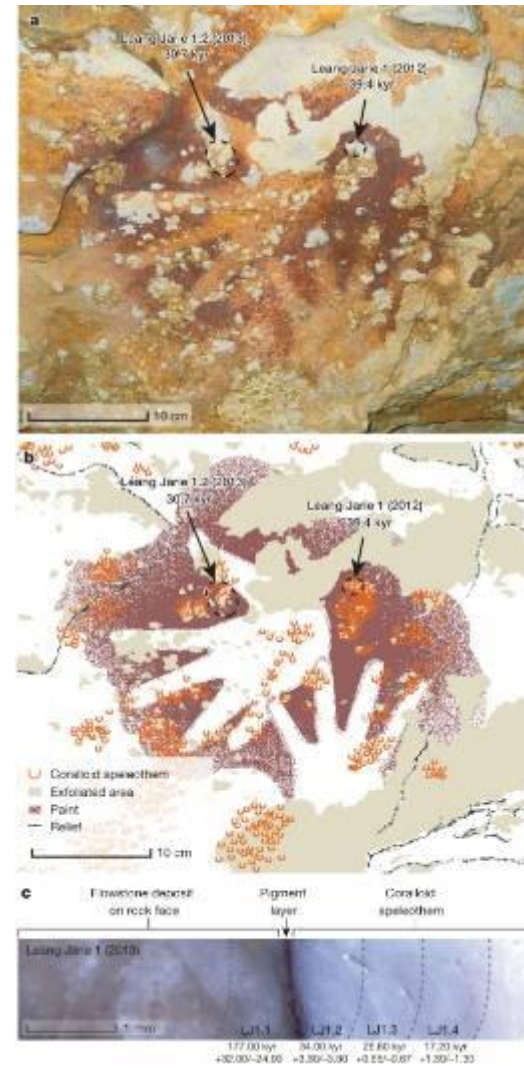
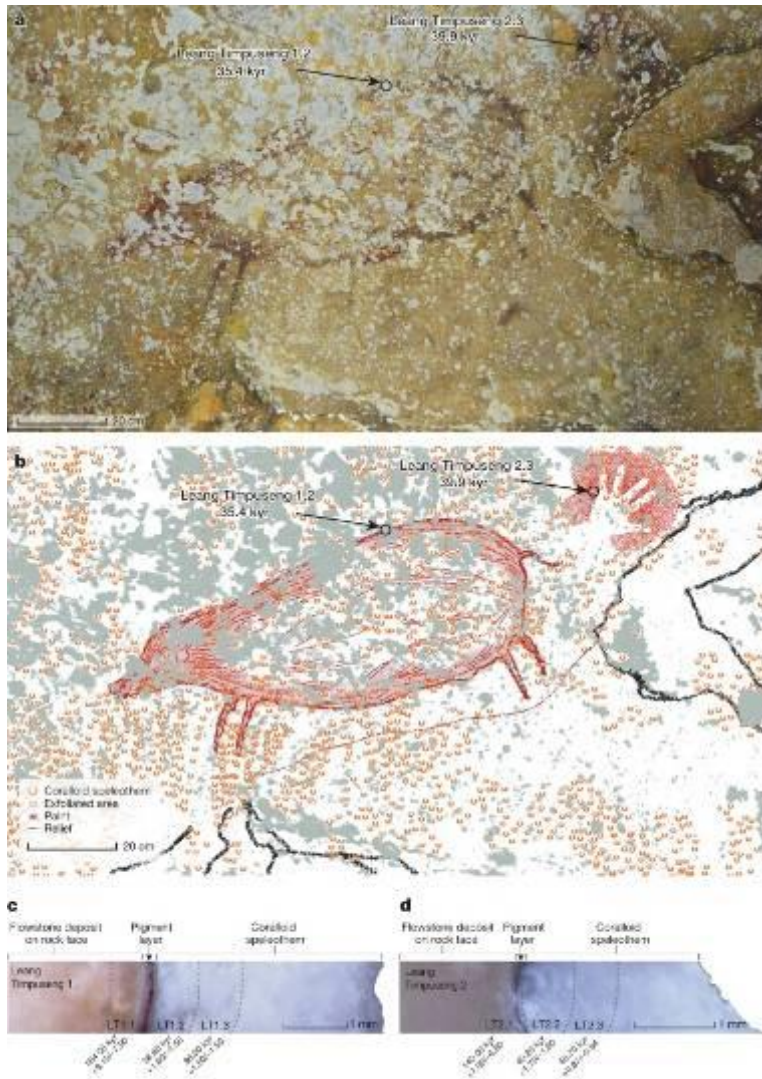
39-28 tys. lat temu
„Kultura orygniacka”

<https://fr.wikipedia.org/wiki/Aurignacien>

Idaç dalej:
Indonezja,
40 tys. lat temu

nature



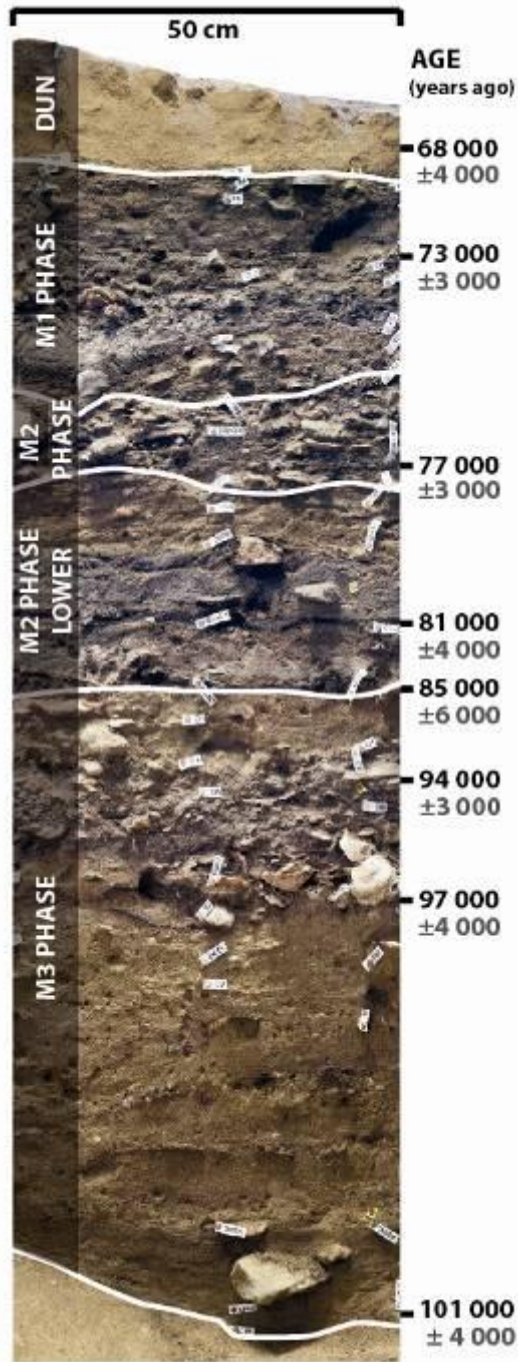


The earliest dated image from Maros, with a minimum age of 39.9 kyr, is now the oldest known hand stencil in the world. In addition, a painting of a babirusa ('pig-deer') made at least 35.4 kyr ago is among the earliest dated figurative depictions worldwide, if not the earliest one.

http://www.nature.com/nature/journal/v514/n7521/fig_tab/nature13422_F3.html

Blombos cave (RPA)

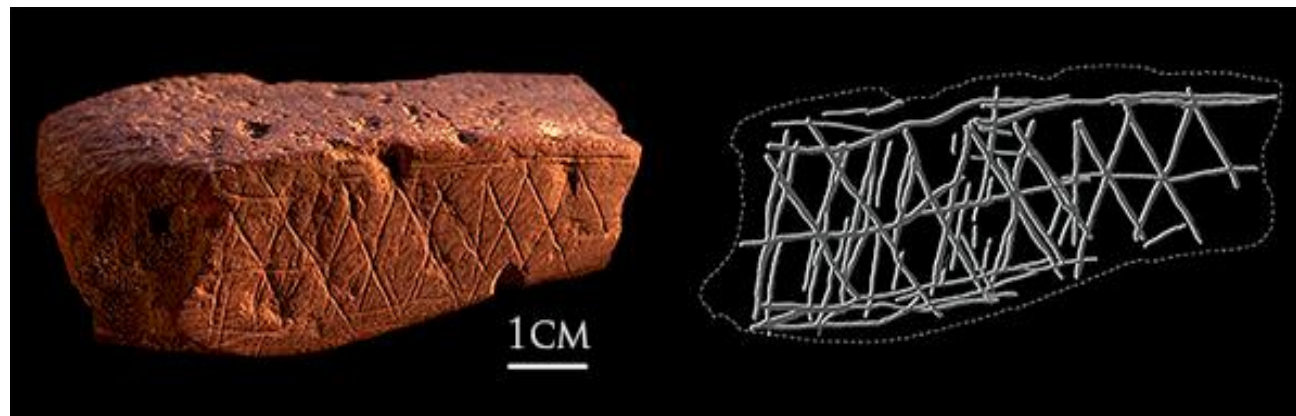
https://en.wikipedia.org/wiki/Blombos_Cave



Skul and Qafzeh, Israel,[\[61\]](#)[\[62\]](#) Oued Djebbana, Algeria,[\[62\]](#) Grotte des Pigeons, Rhafas, Ifri n'Ammar and Contrebandiers, Morocco[\[63\]](#) .[\[64\]](#)

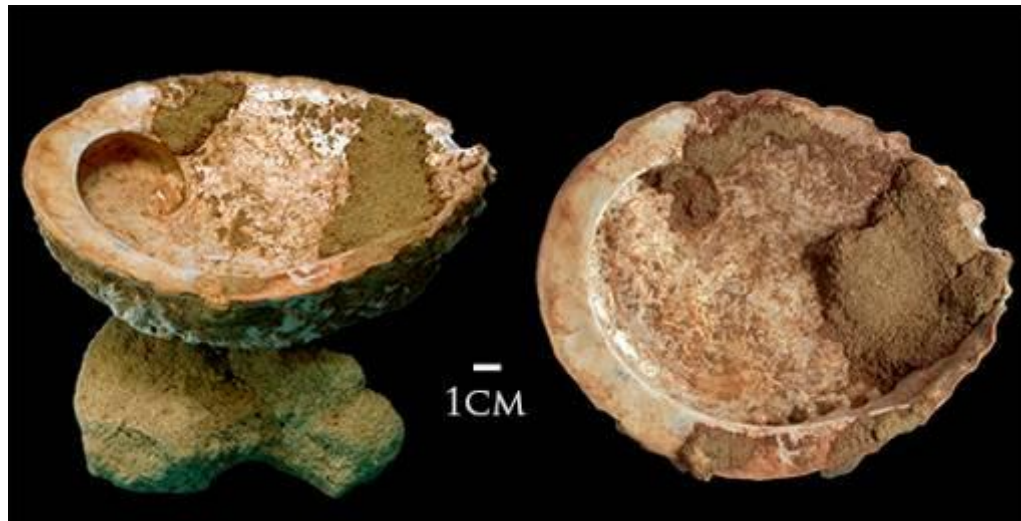
Blombos cave: bardzo daleko, bardzo, bardzo dawno

- In 2002 the recovery of two finely engraved ochre pieces – both deriving from the Still Bay units (M1 phase) – was reported in Science Magazine.[\[10\]](#) The surfaces of both pieces were intentionally modified by scraping and grinding, and the engraved pattern formed a distinct cross-hatched design in combination with parallel incised lines.
- In 2009, six additional pieces of engraved ochre – this time recovered from entire Middle Stone Age sequence dated to between 70,000 and 100,000 years old – were announced.[\[9\]](#)



Blombos cave: bardzo, bardzo daleko, bardzo, bardzo dawno

- In 2008 an ochre processing workshop consisting of two toolkits was uncovered in the 100,000-year-old levels at Blombos Cave, South Africa.^[3] Analysis shows that a liquefied pigment-rich mixture was produced and stored in the shells of two *Haliotis midae* (abalone), and that ochre, bone, charcoal, grindstones and hammer-stones also formed a composite part of the toolkits



Moździerz z muszli do ugniatania ochry



Naszyjnik z muszli

Neuropsychologia

- „Nasza samica szympansa nie może mówić, nigdy nie nauczyła się rozniecać ognia, nie umie gotować, nie rozwinęła talentów artystycznych, muzycznych ani literackich, nie jest specjalnie szczodra, nie jest monogamiczna i nie umie uprawiać żadnych roślin.”
- „Ale pociąga ją mocny partner, rozumie swoje położenie, jest wszystkożerna i lubi socjalizować się, wyruszać na polowanie, dobrze zjeść i utrzymywać bliskie kontakty ze swoim partnerem.”
- „Szympansy, kruki i delfiny potrafią używać kije, trawę i gąbki jako narzędzia. Ale jak dotąd, żadne z nich nie zdołało skonstruować Maserati.”
- „To byłoby na tyle! Idę pielęgnować moją winnicę. Moje winogrona Pinot dadzą wkrótce znakomite wino. Jestem po prostu szczęśliwy, że nie urodziłem się szympansem.”

Gli soffiò nelle narici un alito vitale e
l'uomo diventò una creatura vivente

