Organization and concerted evolution of a novel yeast CDEI-like repeat cervid satellite DNA

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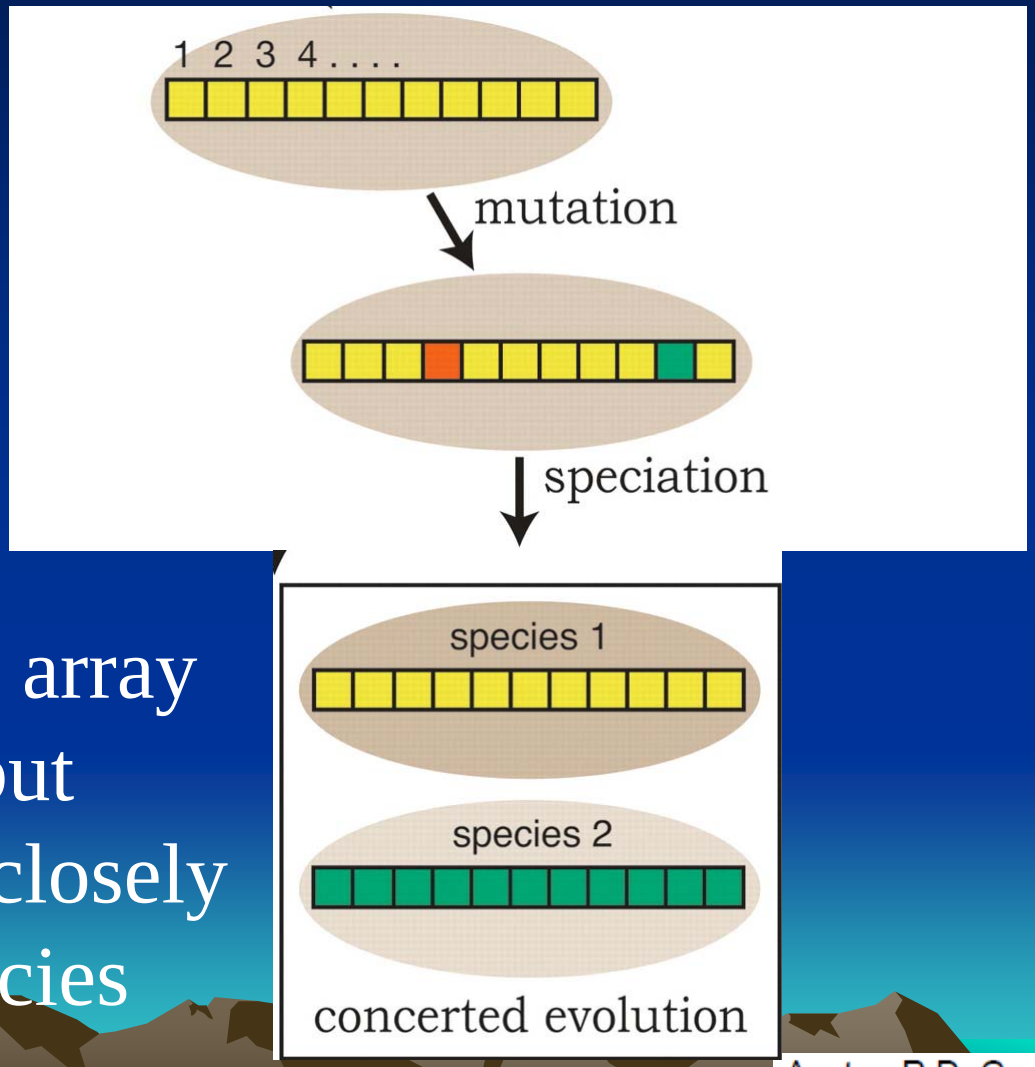
Satellite DNA

- A highly tandem repetitive DNA
- Mainly localized in the telomeric and centromeric region of chromosomes of complex eukaryotic species

Centromeric satellite DNAs

- Contribute to the most centromeric DNAs
- Recognized by some constitutive centromeric proteins
  - CENP-B / human alpha satellite DNA
  - CENP-A / cervid (deers) satellite II DNA.
- Highly diverse among species

Satellite DNAs during speciation

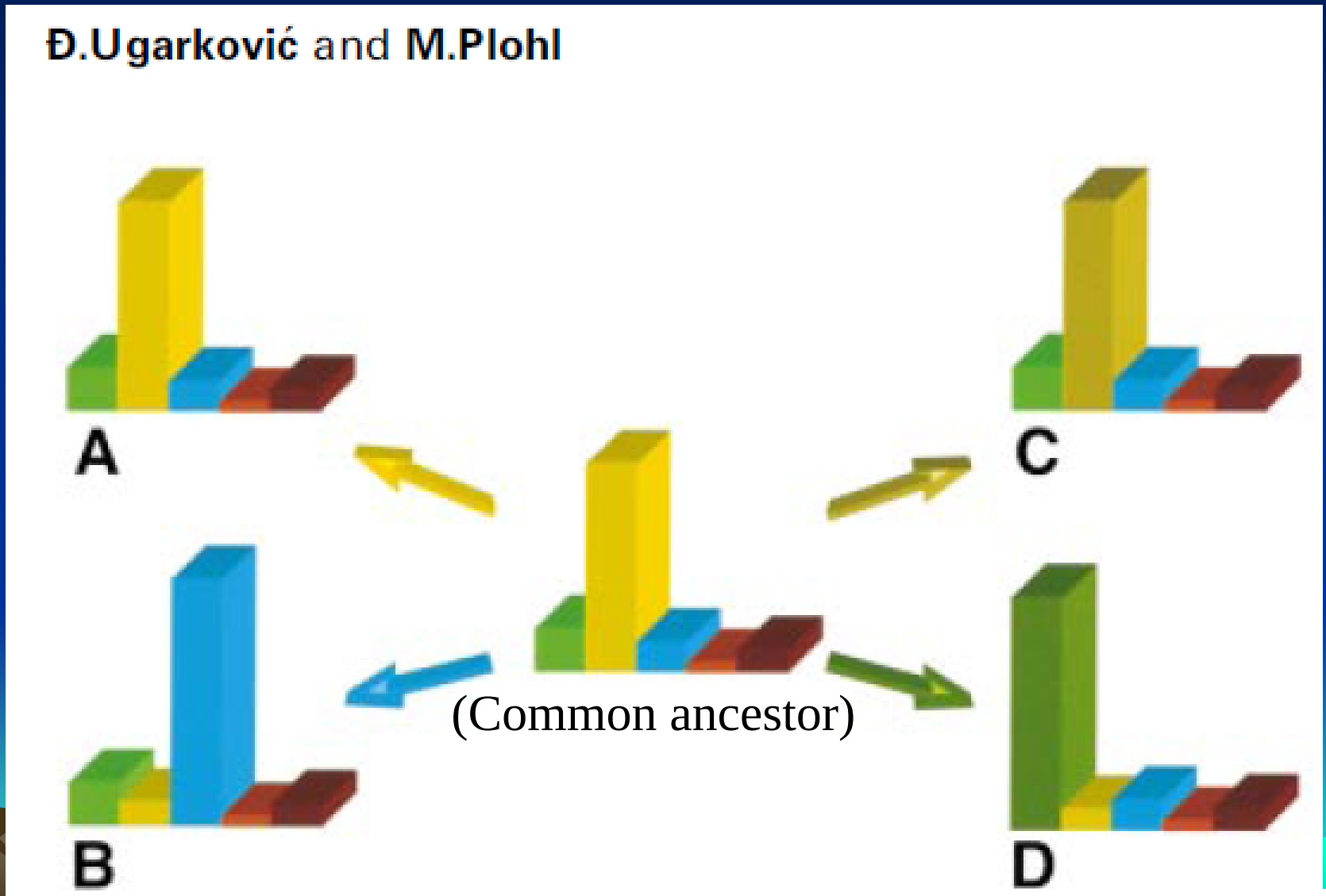


A repeated array is similar but differ in a closely related species

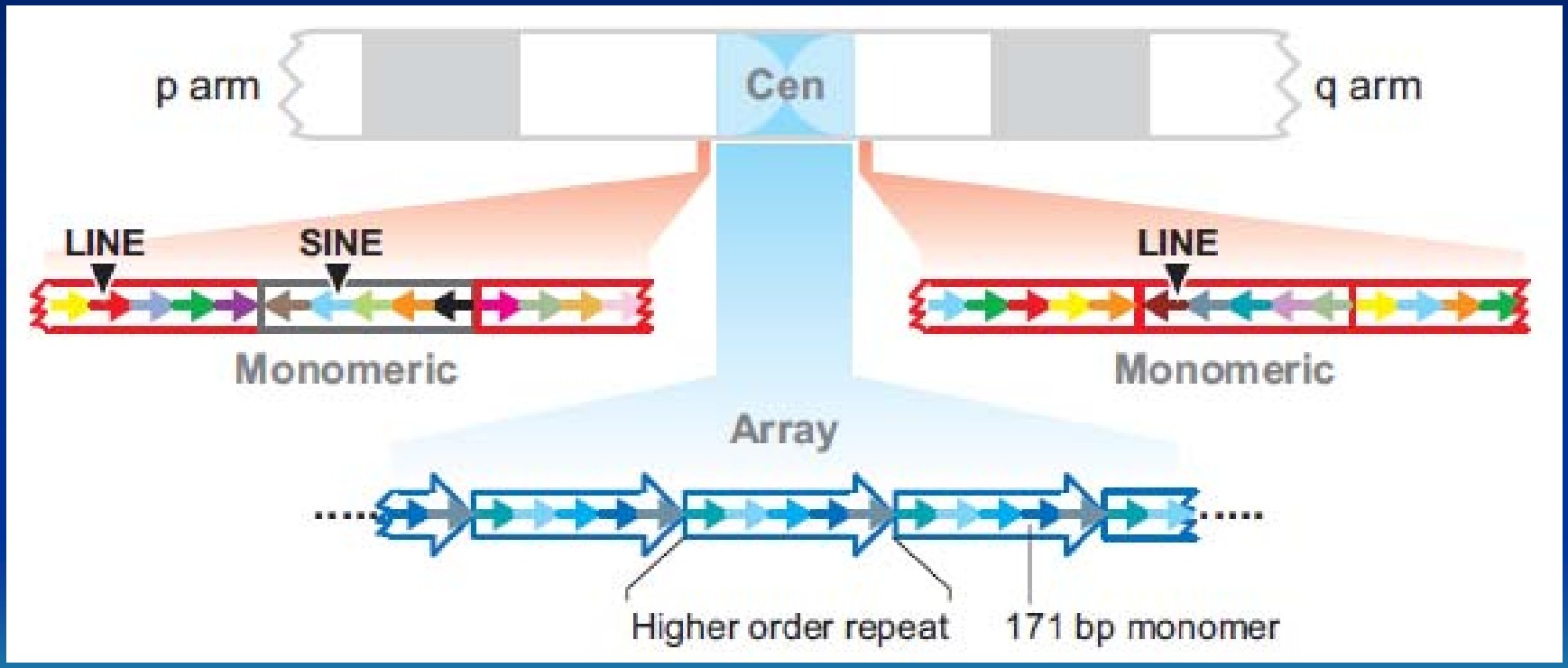
Austen R.D. Ganley and Takehiko Kobayashi

Genome Res. 2007 17: 184-191

- 1976 Salser et al. proposed the “satellite DNA library” hypothesis

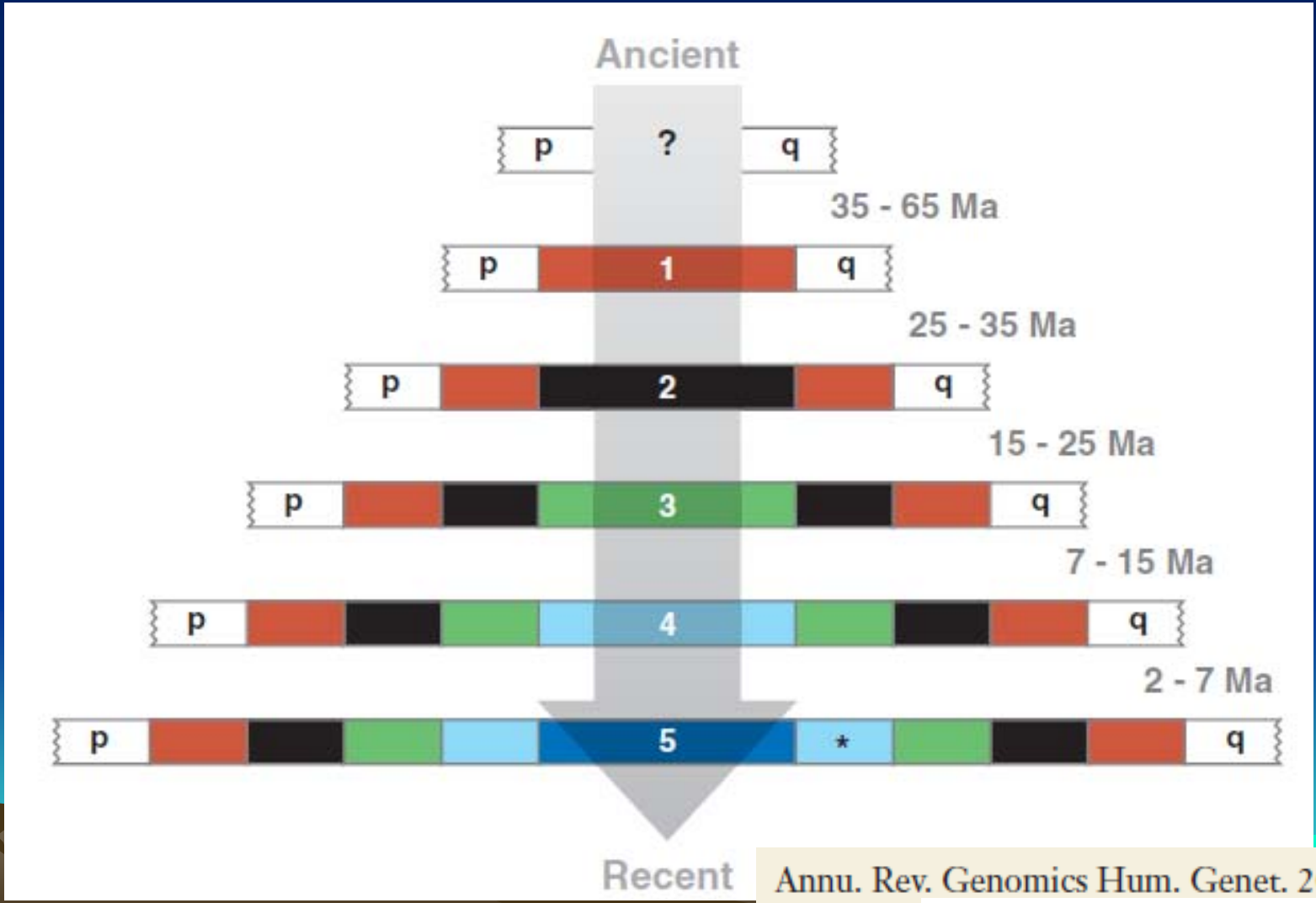


Structure organization of human centromeric and pericentromeric regions



Annu. Rev. Genomics Hum. Genet. 2006. 7:301–13
Mary G. Schueler[1] and Beth A. Sullivan[2]

Hypothetical progressive proximal expansion model



Annu. Rev. Genomics Hum. Genet. 2006. 7:301–13
Mary G. Schueler[1] and Beth A. Sullivan[2]

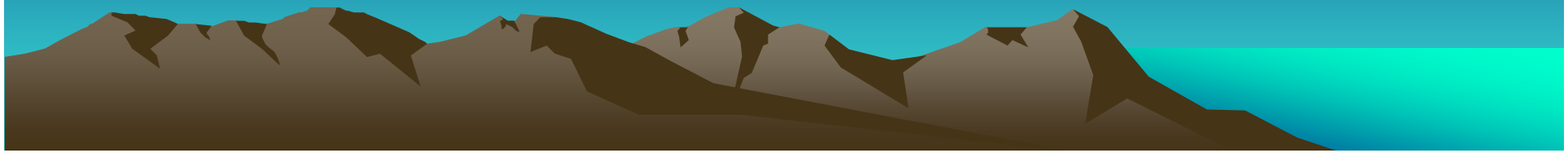
A pericentromeric satellite DNA

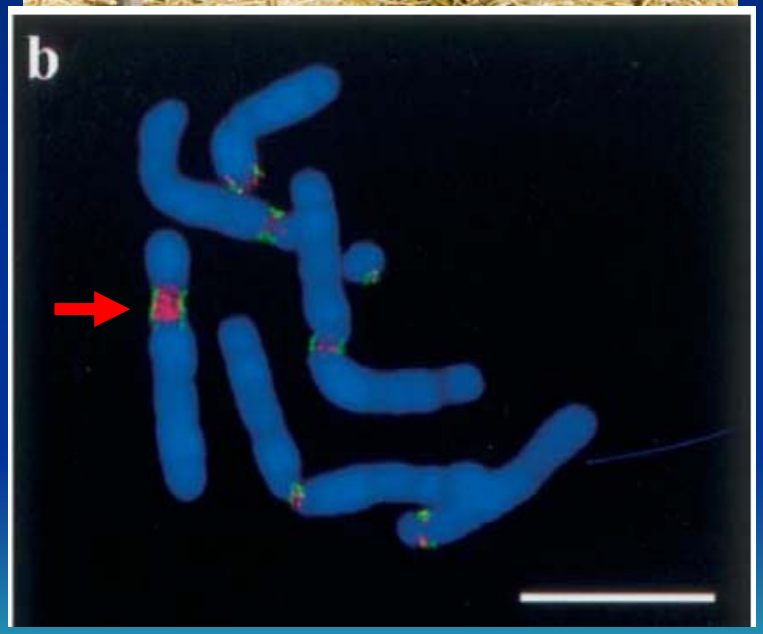
- Originated from the progressive proximal expansion of ancient centromeric DNA.
- Organized as monomeric repeats
- Interrupted by interspersed element (the older one exists in the more distal pericentromeric regions)

What is the ancient centromeric DNA of mammals?

because of

1. Considerably diverse centromeric DNA
2. Uncompleted sequencing of the centromeric/pericentromeric regions
3. the centromeric region of chromosomes in most mammals is usually too small to dissect





Indian muntjac
(*Muntjacus muntjak*)

2n = 6/7

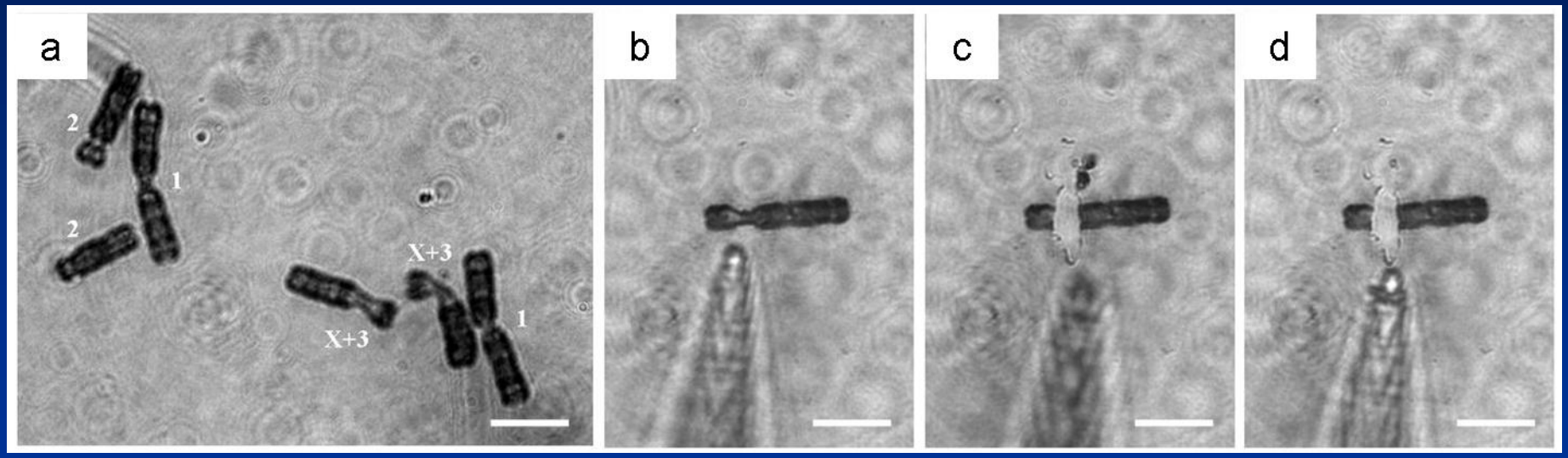
2n = 46

male
(*Homo sapiens*)

2n = 46

Chinese muntjac
(*Muntjacus reevesi reevesi*)

Microdissected the pericentromeric/centromeric DNAs of chromosome X+3 of Indian muntjac

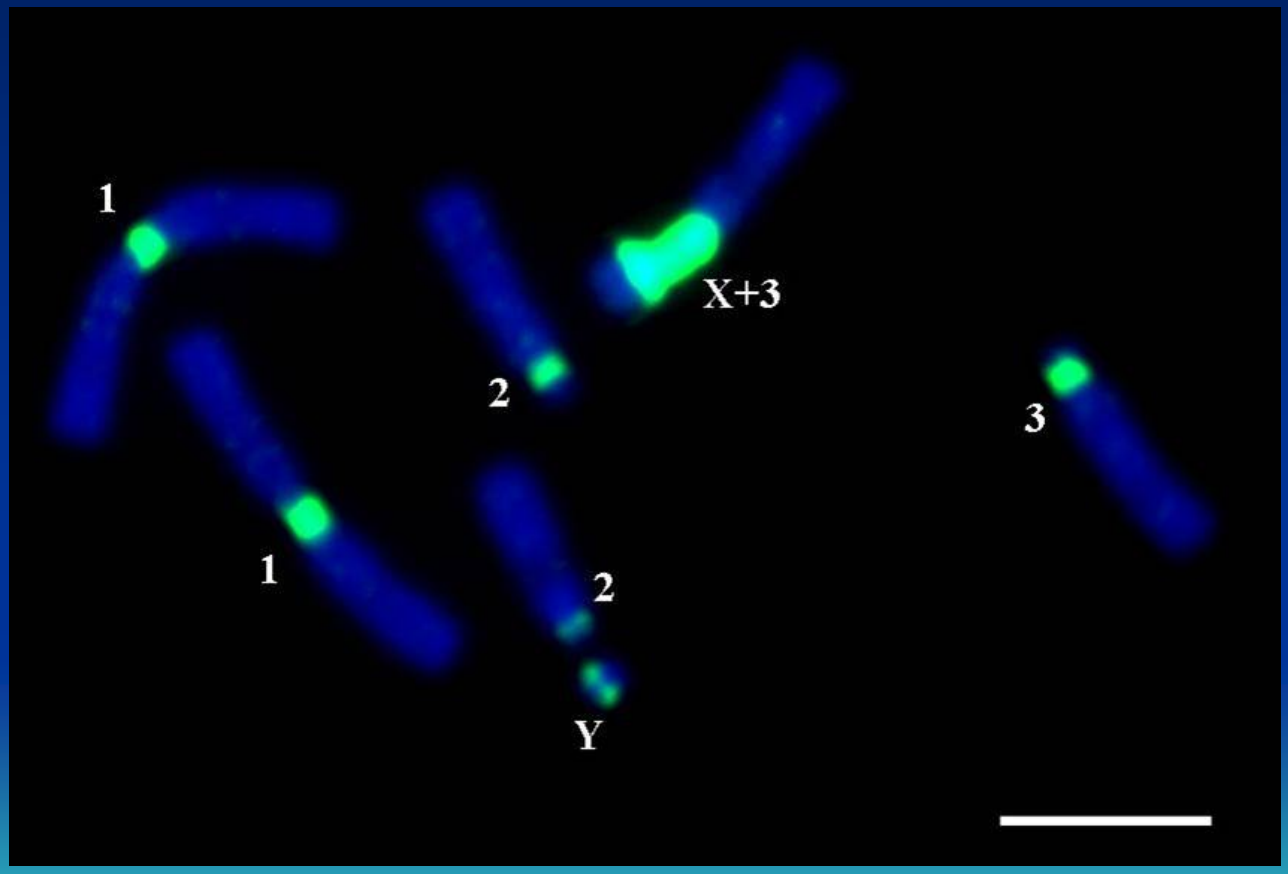


DOP-PCR ← FISH confirm

Mini-library

30/576 microclones had strong DOP-PCR signal but negative satI-V signals

Location of DOP-PCR amplified the microdissected DNAs

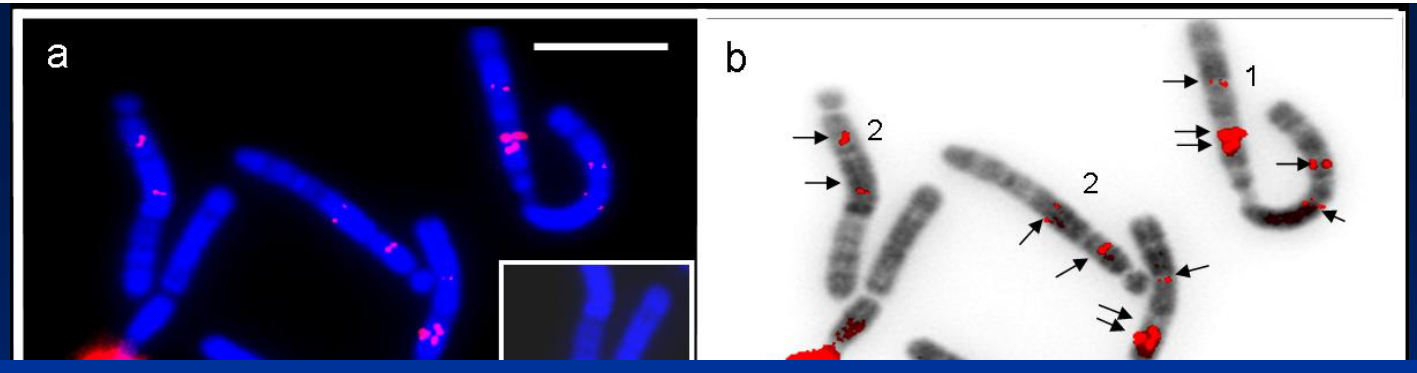


11 bp-tandem repeats

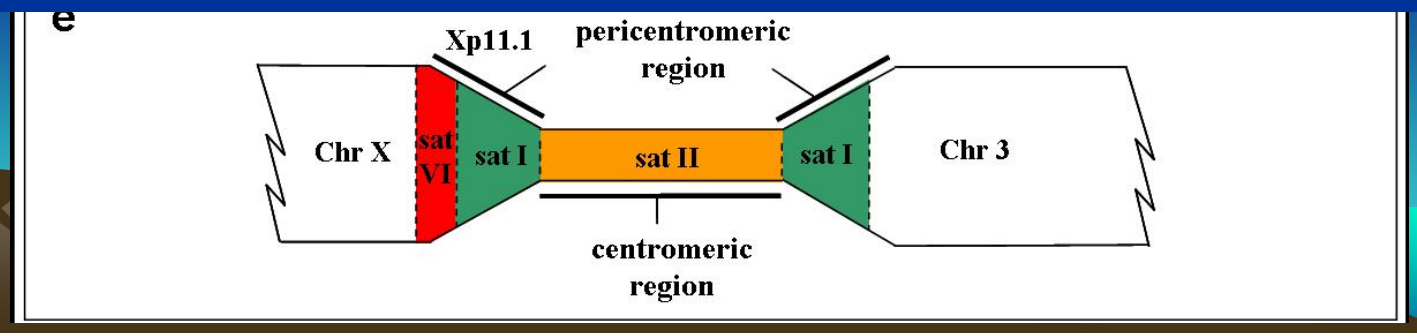
1 GAATCAGTTGGGA	14 ATCACGTGTCA	25 ATCACGTGGGA	36 ATCACGTGGGA	47 ATCACGTGTCA
58 ATCACGTGGGA	69 ATCACCTGTCA	80 ATCACGTAGGA	91 CTCACGTGAAA	102 ATCACGTAGGGA
114 ATTACGTGTCA	125 ATCACGTATGA	136 ATCACGTGGGA	147 ATCACGAGCCA	158 TTCACGTGGCA
169 ATCACGTGGGA	180 ATCTCATGGGA	191 ATTACGTGGCA	202 ATCACCTGTCA	213 ATCACGTGGGA
224 ATCACGAGGGA	235 ATCACGTGGGA	246 ATCATGGGTCA	257 ATCACGTGGGA	268 ATCACGTGGGA
279 ATCACGTGGGA	290 ATCACGTGGGA	301 ATCACGAT-TCA	312 TTCACGTGGGA	323 ATCCCGTGGGA
334 ATCACGTGTCA	345 ATCACGTGGGA	356 ATCACGTGGGA	367 ATCAGGTGGGA	378 ATCACTTGGGA
389 ATCATGTGTCA	400 ATCACGTGTGA	411 ATCACGTGTCA	422 ATCACGTGGGA	433 ATCACGTGGGA
444 ATCACGTGTCA	455 ATCACGTGGGA	466 ATCACGAGTCA	477 TTCACGTGGGA	488 AACACGTGTCA
499 ATCACGTGGGA	510 ATCACGTTCGT	521 CTCACTTGGGA	532 ATCACGTGTCA	543ATCATGTGGGA
554 ATCATGTGTCA	565 ATCACGTGGGA	576 ATCACGTGTCA	587 ATCACATGGGA	598 ATAATGTGTCA
609 ATAACATTGGT	620 TTCAGGTGGGA	631 ATCACGAATCA	642 ATCACGTGGGA	653 ATCACGTTTGA
664 ATCACGTGTCA	675 ATCACGTGGGA	686 ATCATGTGGAA	697 ATCAC	702 CTGTCAT

Cervid satellite VI DNA

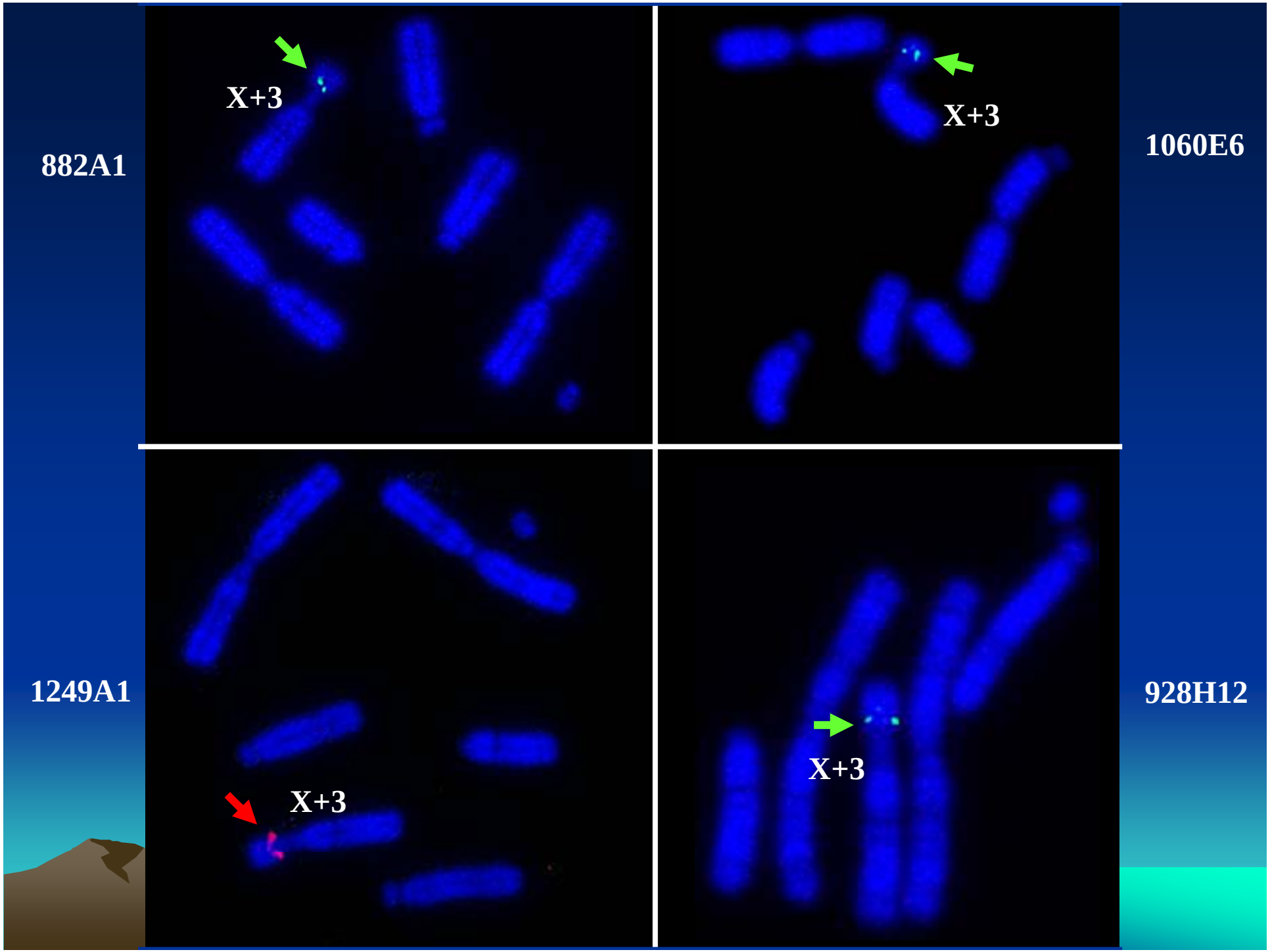
- Organized in a 11 bp repeated array
- Contained the conserved CDEI sequences in most monomers



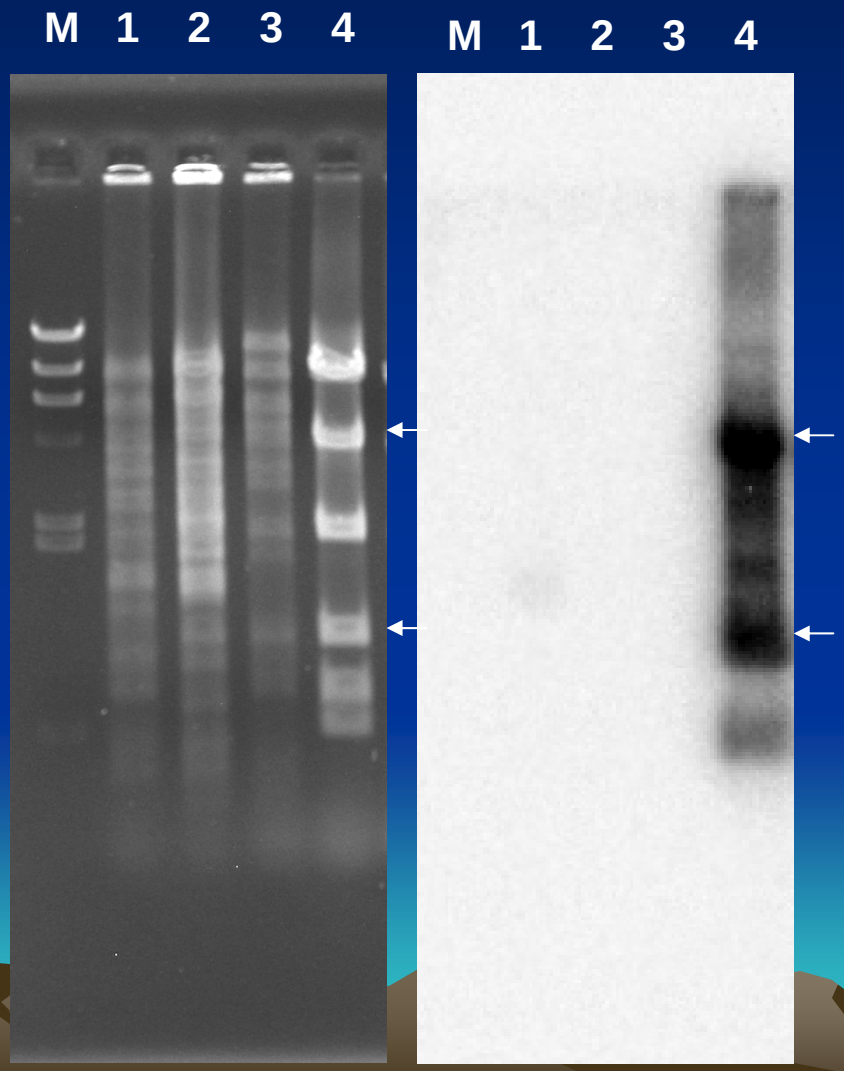
- This novel satellite VI DNA is distal pericentromeric location than the satellite I DNA
- The interstitial satellite VI signals indicated that satellite VI is preserved in the fusion sites of chromosomes of ancestor-like cervids



What is the genomic organization of the satellite VI DNA?


882A1
X+3
X+3
1060E6
1249A1
X+3
X+3
928H12

Southern blot of IM BAC clones

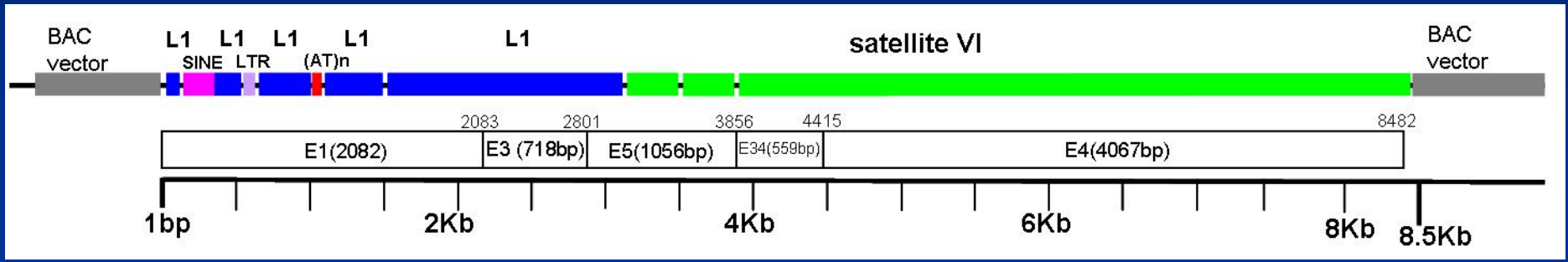


SatVI-1C5 as a probe

M, λ *l*HindIII
1, IM04-882A1
2, IM04-928H12
3, IM04-1060E6
4, IM04-1249A1

The genomic organization of satellite VI DNA

- 5,463-bp satellite VI array adjoins a 3,019-bp interspersed repeats

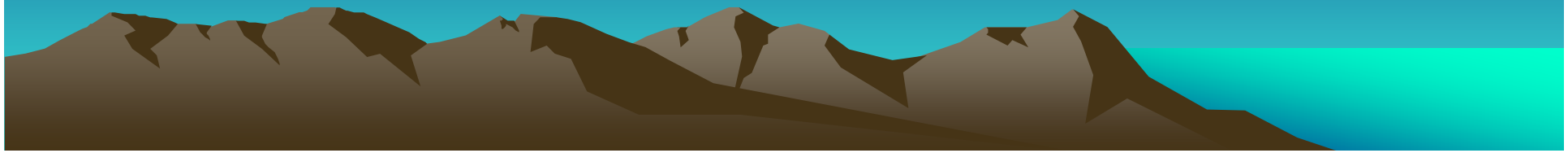


The genomic organization of satellite VI DNA

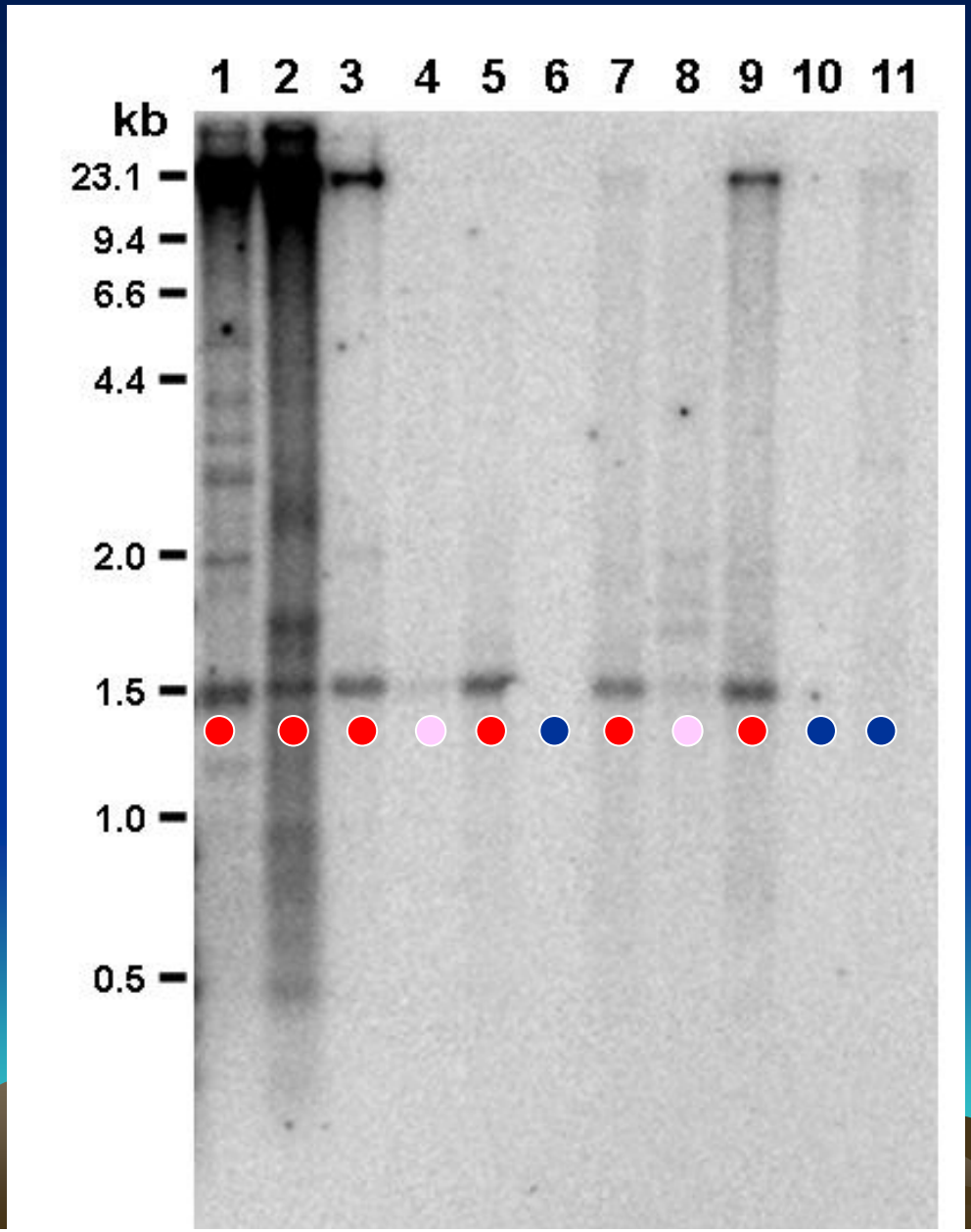
- Monomeric but not higher order repeated organization
- Interrupted by interspersed repeats

Whether

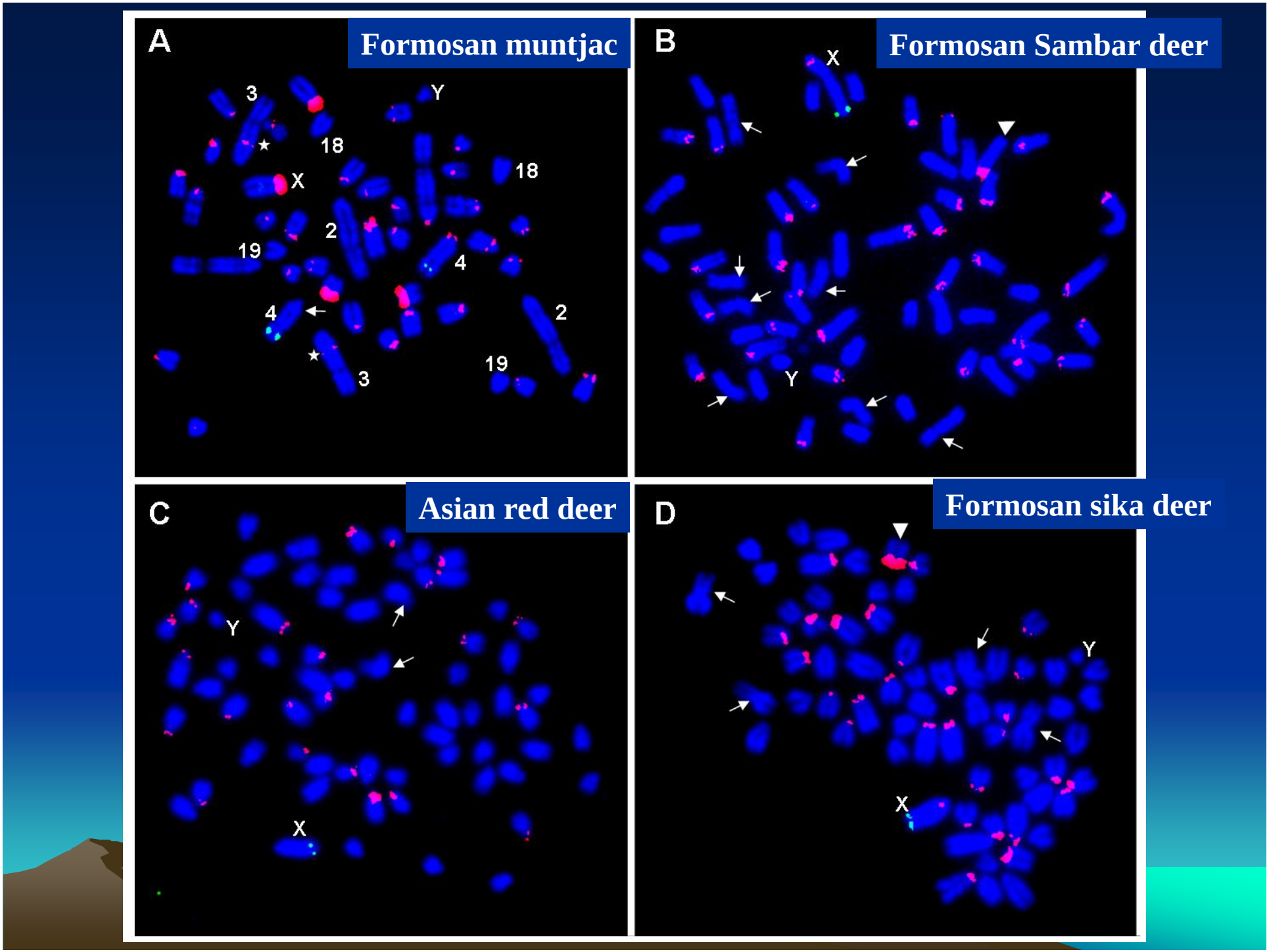
satellite VI exist in other species?



Zoo blot analysis of satellite VI

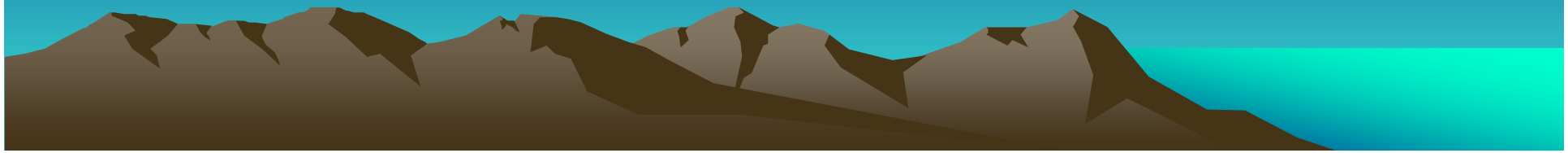


- lane 1: Indian muntjac
- lane 2: Formosan muntjac
- lane 3: Sambar deer
- lane 4: caribou
- lane 5: black-tailed deer
- lane 6: Chinese water deer
- lane 7: bull
- lane 8: boar
- lane 9: goat
- lane10: rat
- lane11: man


A
Formosan muntjac
3
Y
18
18
X
2
19
4
4
2
3
19
B
Formosan Sambar deer
X
Y
C
Asian red deer
Y
X
D
Formosan sika deer
Y
X

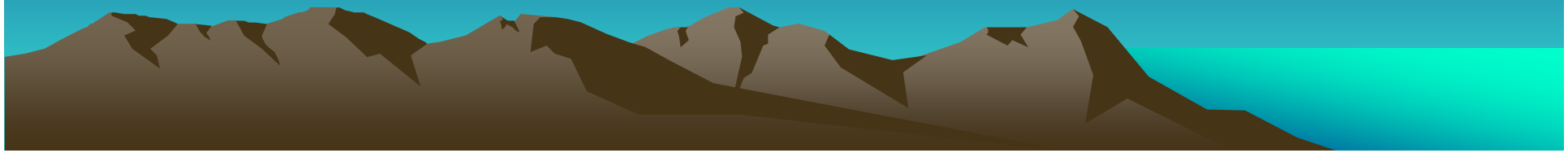
- But no detectable FISH signals of satellite VI in roe deer, black tailed deer, caribou, Chinese water deer, bull, goat, boar, and human

Conclusions and Discussions



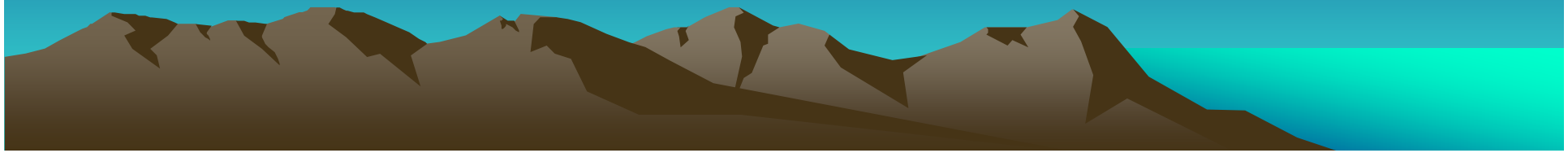
Conclusion 1:

cervid satellite VI DNA could be the vestige of an ancient centromeric DNA



Conclusion 2:

Concerted evolution conducted the cervid satellite VI in the related deer species



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