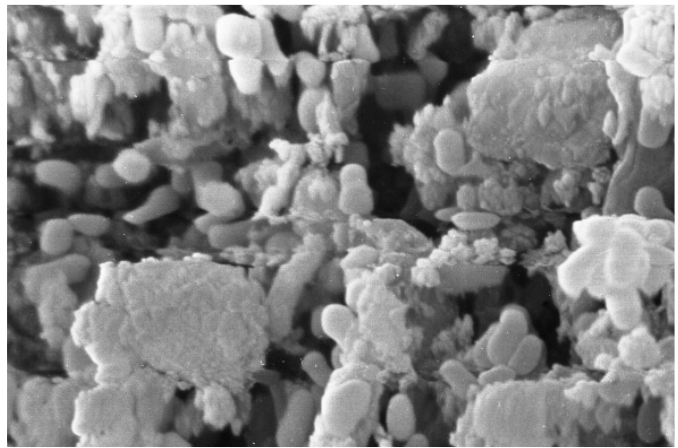


Xenorhabdus

New insight into diversity



*In honour of
Noël BOEMARE*

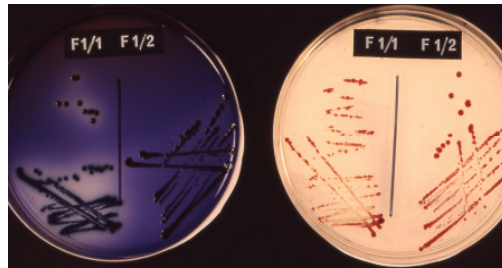


Gnotobiology of Steinernema

*1982 : First studies on occurrence of toxicogenesis by the germ free *S. carpocapsae* in the germ free insect *Galleria mellonella**



Taxonomy & phase variation



*1984 : First studies on DNA relatedness and phenotypic characterization of the genus *Xenorhabdus**

*1988 : Biochemical and physiological characterization of colony form variants and numerical taxonomic studies of the genus *Xenorhabdus**

Photorhabdus gen. nov.

P. temperata sp. nov.

P. luminescens

P. asymbiotica sp. nov.



P. luminescens subsp. luminescens subsp nov.

P. luminescens subsp. akhurstii subsp nov.

P. luminescens subsp. laumondii subsp nov.

P. temperata subsp. temperata subsp nov.

P. asymbiotica subsp. asymbiotica subsp. nov

P. asymbiotica subsp. australis subsp. nov

1993 : Proposal to transfer Xenorhabdus luminescens to a new genus, Photorhabdus gen. nov.

1996 : Characterization of nematode symbionts and clinical strains of the genus Photorhabdus

1998 : Polyphasic classification of the genus Photorhabdus and proposal of new taxa

2004 : Taxonomy of Australian clinical isolates of the genus Photorhabdus and proposal of two new subspecies

Xenorhabdus

New insight into diversity

Tailliez P., Pagès S., Ginibre N. & Boemare N.

*26 Xenorhabdus strains and 50 new isolates
isolated from over 27 Steinernema species*

« **carpocapsae group** »

S. carpocapsae
S. kushidai
S. rarum
S. scapterisci
S. siamkayai

« **feltiae group** »

S. affine
S. feltiae
S. intermedium
S. kariii
S. kraussei
S. monticolum
S. sangi
S. scarabaei
S. weiseri

« **glaseri group** »

S. apuliae
S. arenarium
S. cubanum
S. diaprepesi
S. glaseri
S. hermaphroditum
S. longicaudum
S. puertoricense

« **bicornutum group** »

S. abbasi
S. bicornutum
S. ceratophorum
S. riobrave

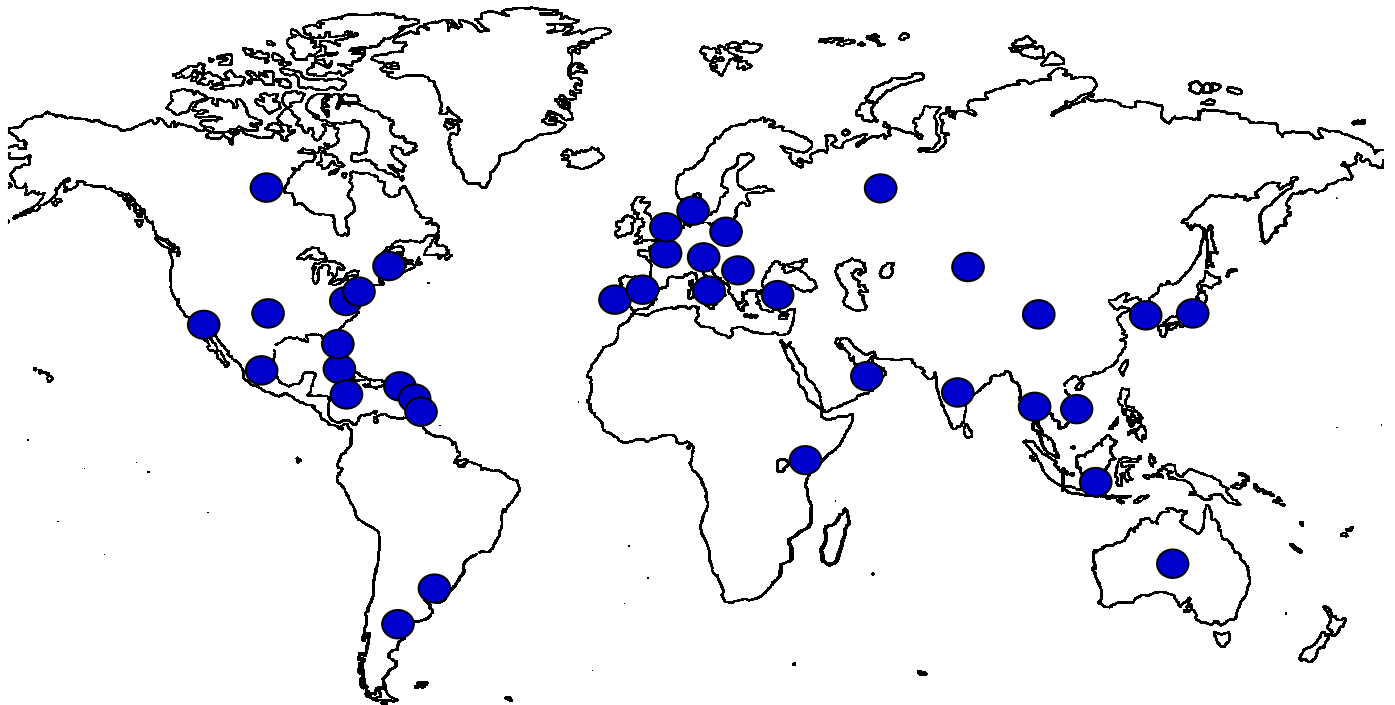
(*S. thermophilum*)

Groups proposed by K. B. NGUYEN

Xenorhabdus

New insight into diversity

*Geographical origin of the nematode hosts
(32 countries)*



Xenorhabdus strains and isolates classification

*All the strains and isolates displayed the phenotypic characters of form I previously described for the genus *Xenorhabdus**

Except strains :

- *X. ehlersii* DSM16337^T*
- *X. japonica* DSM16522^T*

Xenorhabdus 16S rDNA sequence classification

✓ *The differences between 2 Xenorhabdus 16S rRNA gene sequences are often less than 3% (and always less than 5 %)*

✓ *The phylogeny based on 16S rDNA sequences is not robust (low bootstrap values at the nodes; different topologies depending on the method of tree reconstruction used)*

Xenorhabdus 16S rDNA sequence classification

Data : 56 sequences

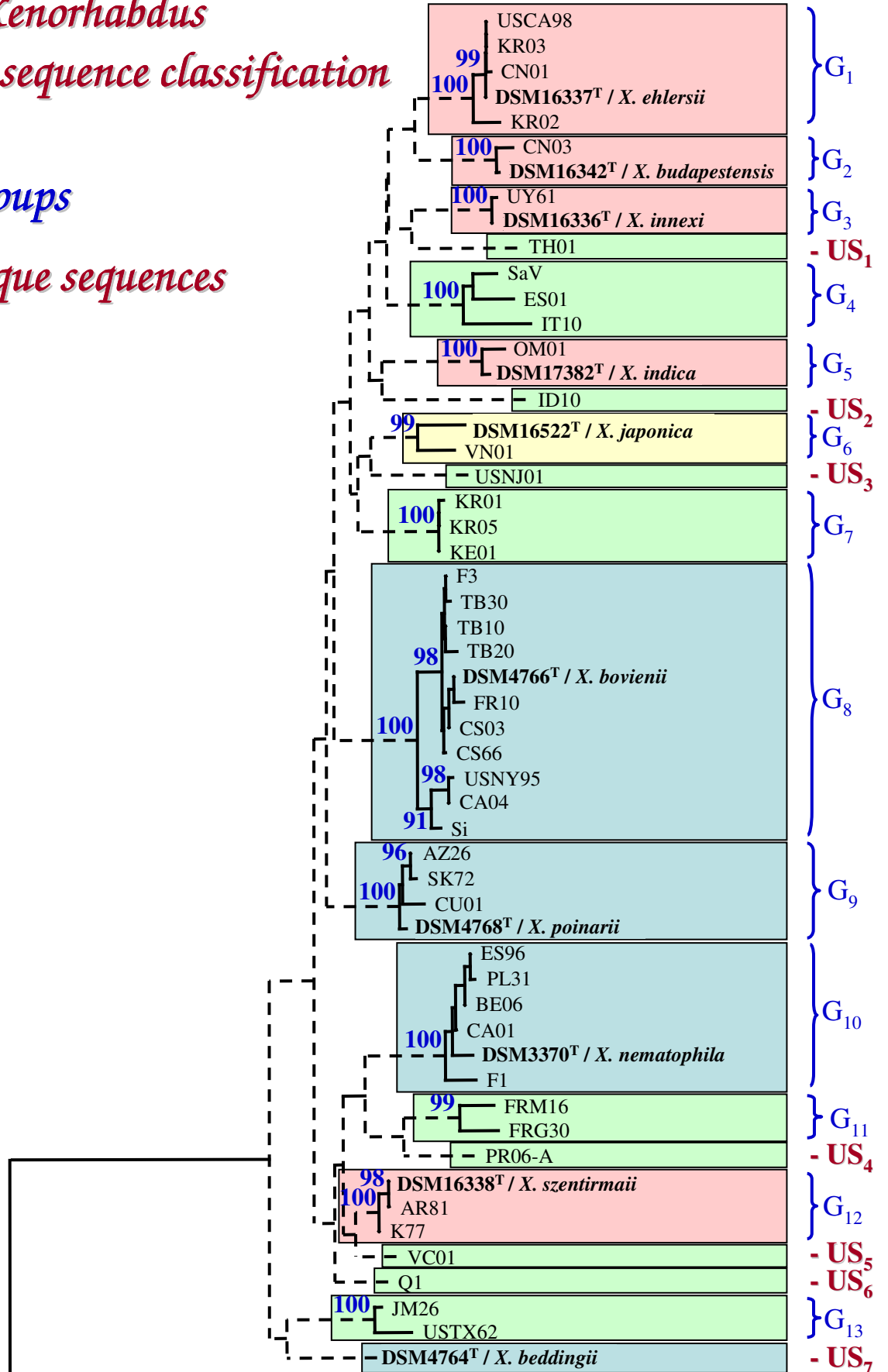
*Amongst *X. bovienii*, *X. nematophila* and *X. poinarii*, we selected representative isolates and strains as a function of their 16S-RFLP profiles and geographical origins*

Xenorhabdus

16S rDNA sequence classification

☞ 13 groups

☞ 7 unique sequences



TTO1^T / *P. luminescens* subsp. *laumondii*

0.01

Xenorhabdus classification based on molecular typing profile (ERIC+RAPD) comparison

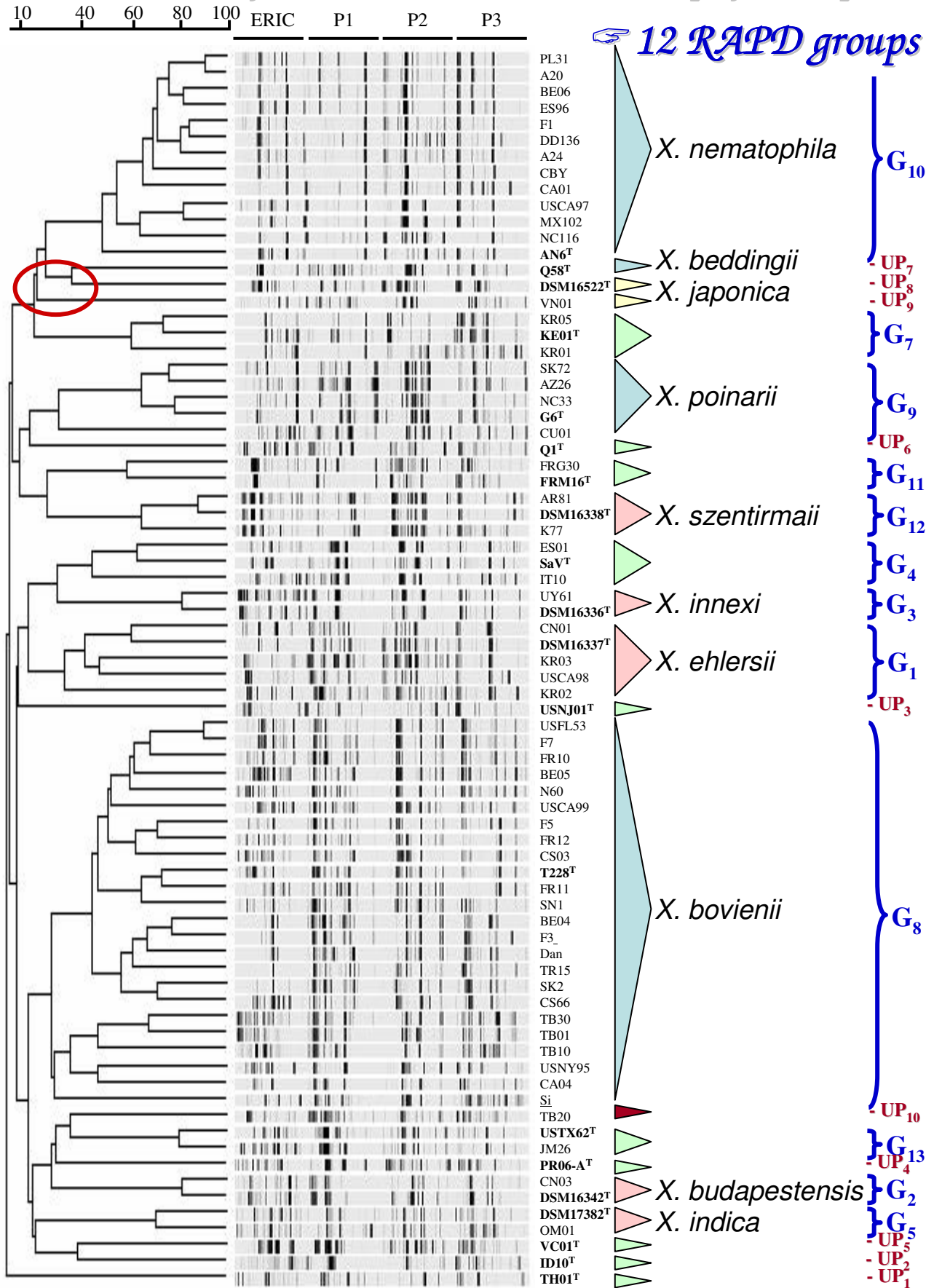
✓ *Approach successfully used for :*

- *Campylobacter (Mazurier et al., 1992)*
- *some closely related species of lactobacilli (Vandamme et al., 1996)*

for which the phenotypic inertness and the overall phenotypic similarity have prevented the development of a phenotypic identification scheme

- *Differentiating Salmonella spp (Lim et al., 2005)*

Xenorhabdus classification based on ERIC-RAPD profile comparison

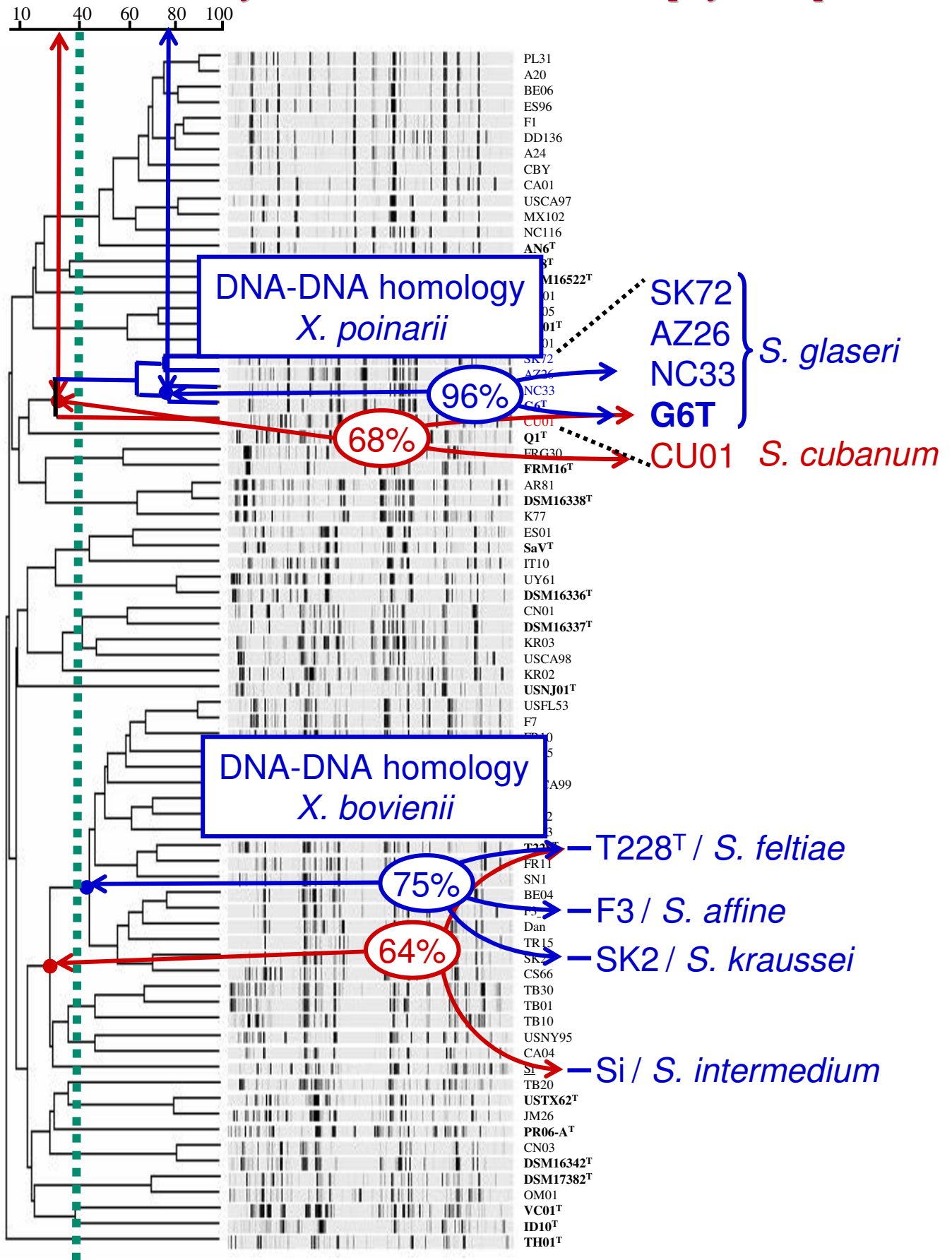


10 unique profiles

*Xenorhabdus classification
based on molecular typing
profile (ERIC+RAPD)
comparison*

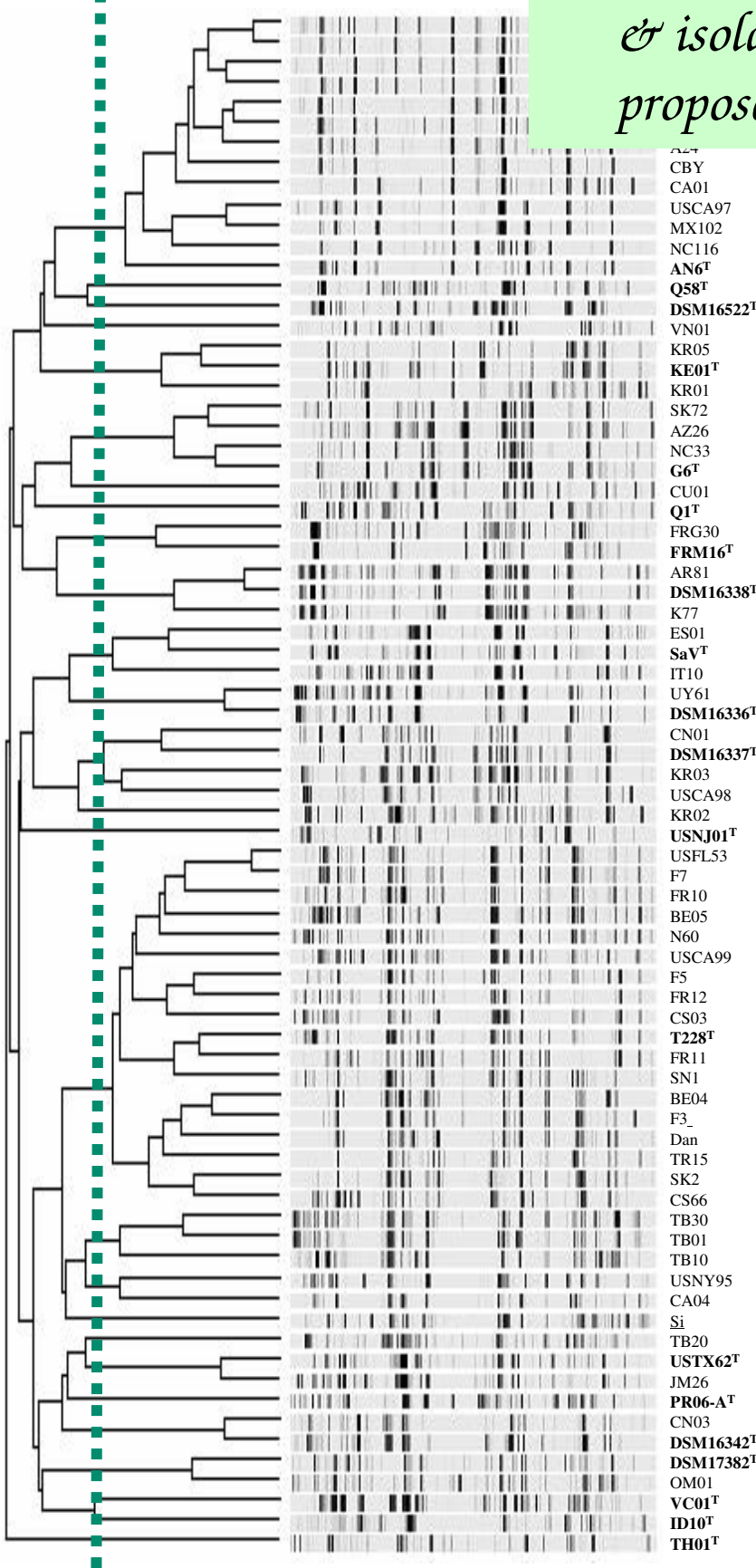
✓ Results consistent with those based on DNA-DNA hybridizations performed on representative strains of the validated species *X. beddingii*, *X. bovienii*, *X. japonica*, *X. nematophila* & *X. poinarii*
+ strains K77 (*X. szentirmaii*), SaV and Q1

Xenorhabdus classification based on ERIC-RAPD profile comparison



Xenorhabdus classification based on ERIC-RAPD profile comparison

10 40 60 80 100



➡ *Assignment of 16 strains & isolates to 10 new proposed species*

➤ *X. hominickii*

➤ *X. miraniensis*
➤ *X. doucetiae*

➤ *X. kozodoii*

➤ *X. koppenhoeferi*

➤ *X. cabanillasii*
➤ *X. romanii*

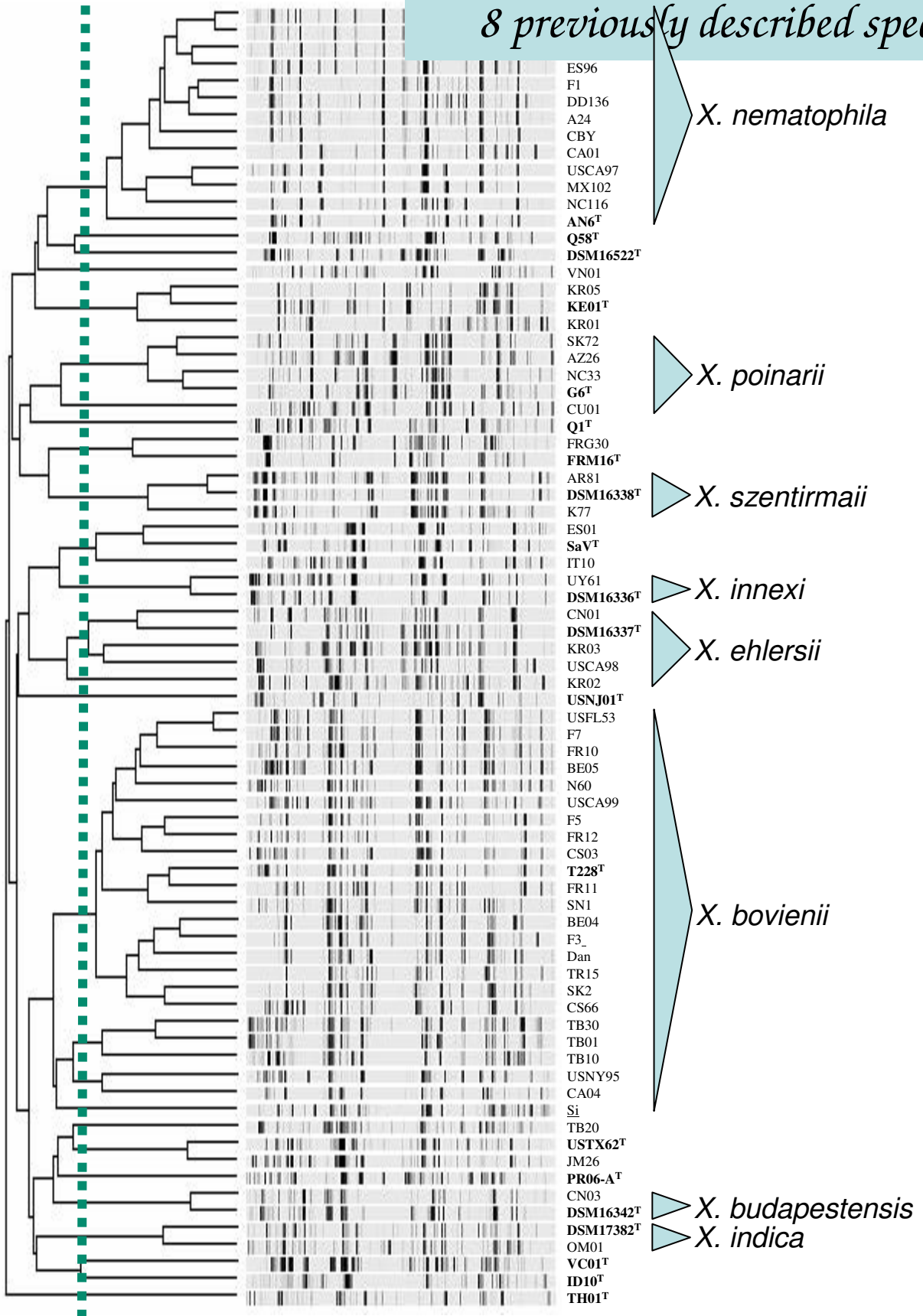
➤ *X. mauleonii*
➤ *X. griffiniae*
➤ *X. stockiae*

- CBY
- CA01
- USCA97
- MX102
- NC116
- AN6^T
- Q58^T
- DSM16522^T
- VN01
- KR05
- KE01^T
- KR01
- SK72
- AZ26
- NC33
- G6^T
- CU01
- Q1^T
- FRG30
- FRM16^T
- AR81
- DSM16338^T
- K77
- ES01
- SaV^T
- IT10
- UY61
- DSM16336^T
- CN01
- DSM16337^T
- KR03
- USCA98
- KR02
- USNJ01^T
- USFL53
- F7
- FR10
- BE05
- N60
- USCA99
- F5
- FR12
- CS03
- T228^T
- FR11
- SN1
- BE04
- F3_
- Dan
- TR15
- SK2
- CS66
- TB30
- TB01
- TB10
- USNY95
- CA04
- Si
- TB20
- USTX62^T
- JM26
- PR06-AT
- CN03
- DSM16342^T
- DSM17382^T
- OM01
- VC01^T
- ID10^T
- TH01^T

Xenorhabdus classification based on ERIC-RAPD profile comparison

10 40 60 80 100

Assignment of 32 isolates to 8 previously described species



Xenorhabdus phenotypic classification

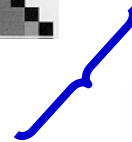
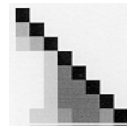
✓ *Data : 153 variable phenotypic characters
76 strains & isolates*

- *Growth at various temperatures from 32°C to 42°C*
- *Enzymatic activities on API20E and API20NE*
- *Carbon source assimilation (Biotype100)*
- *Fermentation on API50CH*
- *Phenotypic tests on agar plates*

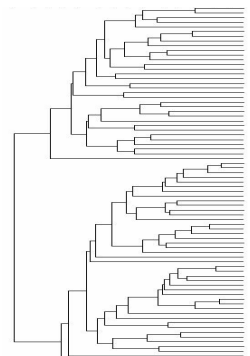
⇒ *5 similarity matrices*

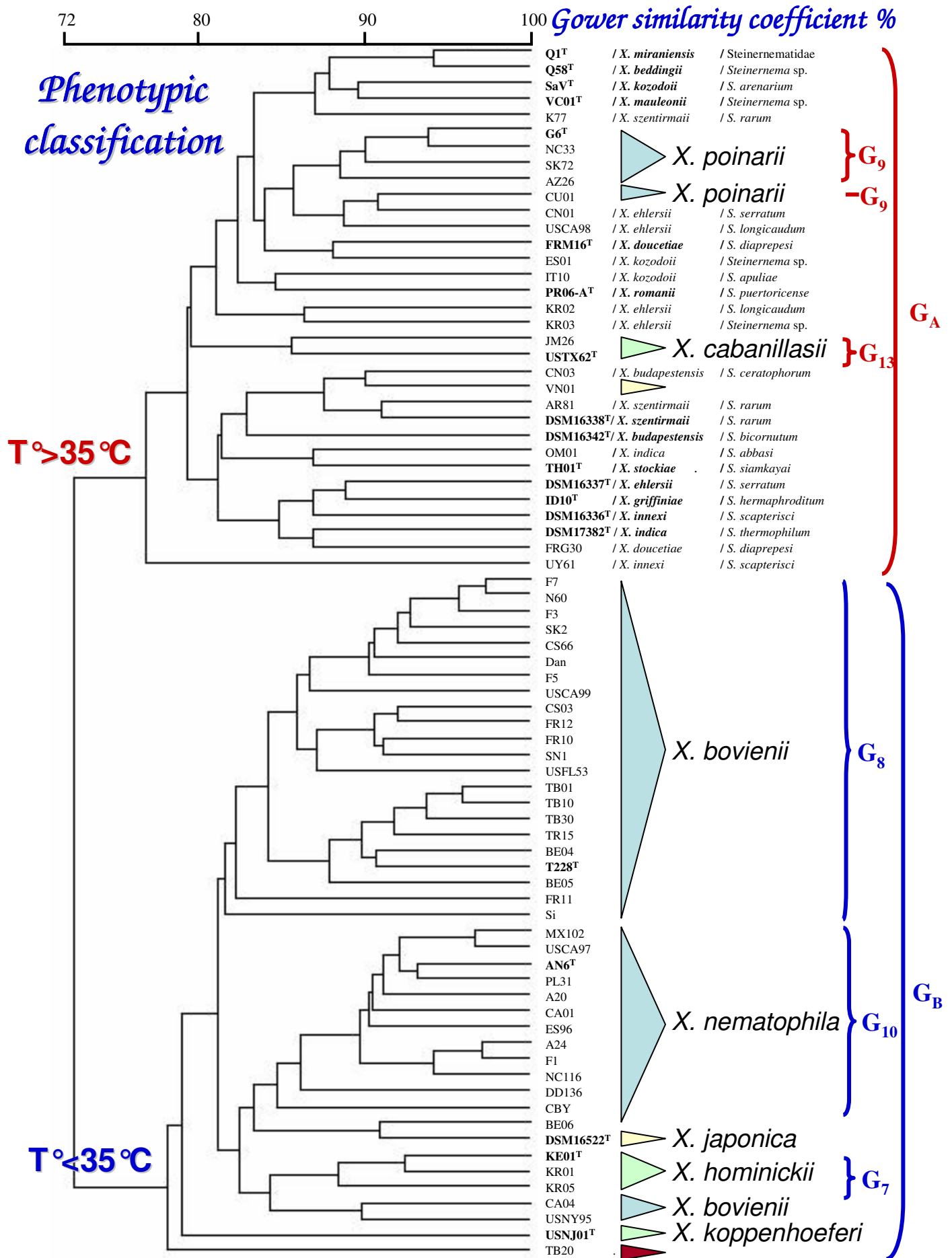


⇒ *1 combined similarity matrix
BioNumerics (Applied-Maths, Belgium)*



⇒ *1 combined dendrogramme
UPGMA*





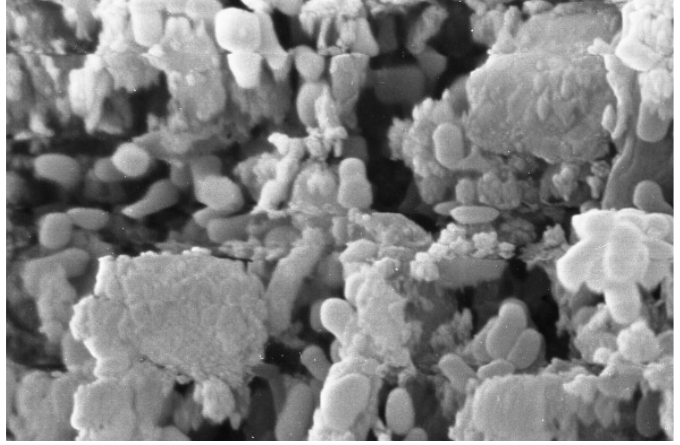
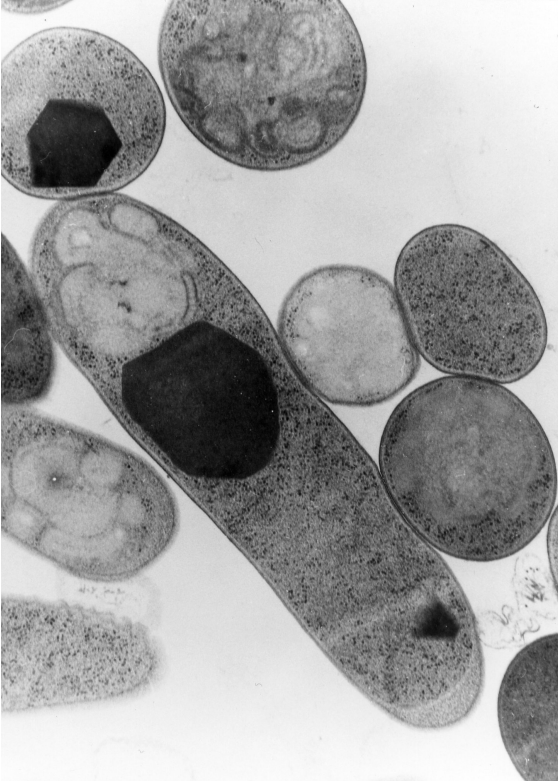
*Optimum temperature for growth and development
of the nematode*

S. carpocapsae (X. nematophila)
S. monticolum (X. hominickii)
S. scarabaei (X. koppenhoeferi)
S. weiseri (X. bovienii) } 20-25°C

S. abbasi (X. indica)
S. riobrave (X. cabanillasii) } 30-35°C

Cabanillas et al., 1994; Elarwad et al., 1997; Mráček et al., 2003; Saunders & Webster, 1999; Stock & Koppenhöfer, 2003; Stock et al., 1997)

<i>Xenorhabdus</i> species	number of strains	host species
<i>X. bovienii</i>	24 (+TB20 ?)	<i>S. feltiae</i> / <i>S. kraussei</i> / <i>S. weiseri</i> / <i>S. affine</i> / <i>S. intermedium</i> / (<i>S. sichuanense</i>)
<i>X. nematophila</i>	13	<i>S. carpocapsae</i>
<i>X. poinarii</i>	5	<i>S. glaseri</i> / <i>S. cubanum</i>
<i>X. ehlersii</i>	5	<i>S. longicaudum</i>
<i>X. szentimaii</i>	3	<i>S. rarum</i>
<i>X. hominickii</i>	3	<i>S. monticolum</i> / <i>S. karii</i>
<i>X. kozodoii</i>	3	<i>S. arenarium</i> / <i>S. apuliae</i> / <i>S. sp.</i>
<i>X. budapestensis</i>	2	<i>S. bicornutum</i> / <i>S. ceratophorum</i>
<i>X. cabanillasii</i>	2	<i>S. riobrave</i>
<i>X. doucetiae</i>	2	<i>S. diaprepesi</i>
<i>X. indica</i>	2	<i>S. thermophilum</i> / <i>S. abbasi</i>
<i>X. innexi</i>	2	<i>S. scapterisci</i>
<i>X. beddingii</i>	1	unknown
<i>X. japonica</i>	1 (VN01 ?)	<i>S. kushidai</i> (<i>S. sangi</i>)
<i>X. griffiniae</i>	1	<i>S. hermaphroditum</i>
<i>X. koppenhoeferi</i>	1	<i>S. scarabaei</i>
<i>X. mauleonii</i>	1	unknown
<i>X. miraniensis</i>	1	Steinernematidae
<i>X. romanii</i>	1	<i>S. puertoricense</i>
<i>X. stockiae</i>	1	<i>S. siamkayai</i>



*Thank you
Noël !*