Supplementary Figure 9.
Clustal Omega sequence alignment of DNA-PKcs from selected metazoan plus putative archaeon sequences.
Panel A: Percent identity of sequences from Clustal Omega. Common names or alternative names are shown in (). See Supplementary Table 1 for full list of organisms, scientific names and accession numbers.

Sequence	% Identity
HUMAN	**100**
MOUSE	**79.3**
TASDEVIL (TASMANIAN DEVIL)	**76.76**
PLATYPUS	**75.02**
TURTLE	**71.88**
ALLIGATOR	**70.21**
OSTRICH	**69.71**
GECKO	**68.56**
CANARY	**67.87**
CAECIL (AMPHIBIAN)	**67.78**
SNAKE	**66.5**
LATIMERIA (COELACANTH)	**65.32**
STERLET (FISH)	**64.8**
XENOPUS	**64.31**
BAMBOO (BAMBOO SHARK)	**62.27**
MILII (ELEPHANT SHARK)	**62.14**
GAR (FISH)	**61.77**

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

DANIO (FISH)	**58.42**
BELCHER (LANCELET)	**43.4**
HEMICHOR (HEMICHORDATE)	**42.68**
STARFISH	**42.66**
NEMATOSTELLA (SEA ANEMONE)	**41.94**
PISTILLATA (STONY CORAL)	**41.19**
STRONG (SEA URCHIN)	**41.07**
SOFT CORAL	**39.91**
POMACEA (SNAIL)	**39.44**
CRASSO2 (OYSTER)	**39.43**
PRIAPULA (WORM)	**39.18**
TRICHOPLAX (PLACAZOA)	**39.01**
CAPITELLA (WORM)	**37.29**
SPONGE	**35.34**
SCORPION	**34.27**
MUDCRAB	**29.72**
"PUTATIVE ARCHAEON"	**21.58**

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

Panel B: Clustal Omega alignment of DNA-PKcs sequences from selected metazoans compared to putative archaeon.
Sequences of selected Metazoans as in Supplementary Figure 2. Sequence names and classification are described in Supplementary Table 2. Colours representing identical, conserved and semi-conserved amino acids, phosphorylation sites and catalytic amino acids are as in Supplementary Figure 2. The putative archaeon sequence accession numbers and the amino acid numbers of the corresponding start and end of each putative archaeon sequences on the human DNA-PKcs sequence is indicted below and in bold/black on the alignment in the following pages.

Archaeon Accession number	Corresponding residue number in human sequence (start)	Corresponding residue number in human sequence (end)
RYG70452.1	**1**	**291**
RYG70451.1	**292**	**1187**
RYG70450.1	**1188**	**3274**
RYG70459.1	**3275**	**4128**

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

CLUSTAL O(1.2.4) multiple sequence alignment

```
                                        Start RYG70452.1 (Archaeon)
ARCHAEON          ------------------------MEALEKLLEDLNRAVETEDA---AVNVASLVASVEA  33
MUDCRAB           -------------------MASGGREDVQDLLEKLHHYSSGN-ELRNARSARDIVVDISE  40
SCORPION          -------------------MNEITNSLHENILKLNDFIKYQK--DEGHSSIYVIKDISE  38
SPONGE            --------------------------MESRIESLWESLHSSS-PQRYSYATEVASDLYS  32
CAPITELLA         ----------------------MARALQEQLAGLVSDTRGQPGVVNARISHESIGNIGA  37
DANIO             -----------------MAADTSTVGGIQGYLLKLHSSLEDTVSTNVAIVCHDIIGDLGQ  43
MILII             -----------------MAGPRGAAADTLSAFSKLHHLLSLSDVKSAAAESHSAVGSISR  43
BAMBOO            ------------MADGMRRHGAGVGLEVERRLQQLEQLLSAQDSRSAAVESHSIVANLTH  48
XENOPUS           MLLAGAGGSSGDGQDGVASGPAESAAGILGRLHQLHGLLSLE-SGVGAEGAHSLLHNLAE  59
STERLET           --------------MAQPGSCSVGAGGIQGNLHKLHSFLNATDAKSAAVESHNLIGNLGQ  46
GAR               --------------------MAGSGGGIQGYLQKLHSLCGAGETKQTALECHSVIGDLGQ  40
LATIMERIA         --------------MAEEGGSPSAVEGVSGYLLKIHSSLTVTDTKSAAIEISNIFGNLRQ  46
CAECIL            --------------MSVPGVGGDSAVGVQGSLLRLHASLSSKDPGLEAPVAQSLIRSLGE  46
SNAKE             ------------MASSL-VVP---GGGLQGFLLQLHDALRSSDASSAALRGCSLIRSVAE  44
CANARY            ------------------------MAGVQQCLLQLHRCLQPGDAGGSALHGYSLLRSLAE  36
OSTRICH           ------------------------------------MCS--------------ERKDVQA  10
GECKO             ------------MAISLPVA----GGGLQGLLLQLHGTLQSPDPASAALHGHSLIRSMAE  44
TURTLE            ------------MAAALPVGG---GGGIQGSLHQLSCALQDPDPGTAALRGYHLIRGVGE  45
ALLIGATOR         ------------------------------------------------------MAALV  5
PLATYPUS          --------------------MAGSVPGPQGSLLRLQRFLEAEDAGVSAVAAYQLIRGLGQ  40
TASDEVIL          --------------------MSGAGGGGLQGSLLQLQELLSGGDPGSAALAAYHLIRAVGQ  41
HUMAN             --------------------MAGSGAGVRCSLLRLQETLSAADRCGAALAGHQLIRGLGQ  40
MOUSE             --------------------MAEEGTGVRCWLLQLQEFLSAADRCSAAGASYQLIRSLGQ  40
CRASSO2           ----------------------MAASLLEDNLRSLNECLTTAD-NSSKEQADSIVADISQ  37
POMACEA           ----------------------MAATLEETLRSLHDQ---SG-ASAYNLANGLIADIRQ  33
TRICHOPLAX        ----------------------MASNLSQLLIDLHALLNLQS-LHRGSNACDIASDITV  36
NEMATOSTELLA      ----------------------MTDAISSRLLQLNELVAEES-PLRGQESAEIARDLRA  36
PRIAPULA          ---------------------MARTVRIEDHVQTLLESLPSDDREADPETAHSAVADLAH  39
SOFTCORAL         ----------------------MTEVIDRYLNQLNSCLKTLSSSRG-REAADICRDLRL  36
PISTILLATA        ----------------------MSDLLNRYLTHLHSL-PSLDAPHCGLDASNTVVDLGS  36
HEMICHOR          ----------------------MPSSELQSKLAELLELLDETPSQHTVEKCNNLIGEIQL  38
BELCHER           ---------------------MAGSGSLEARLSELHALLAESDHGHGAVEAHNLVADIAQ  39
STRONG            ----------------------MAAAELQRHLAELHEVIDSGGTAHGPETAQDLVVDIAQ  38
STARFISH          ----------------------MATADLPVKLSELNGLISTKSGLHVAEKAQDLVVDLGH  38
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                RYG70452.1
ARCHAEON            IGSGDL-DELD-LDTCTALLLAPGQTASGLPGDSIKRSSSSLMQFLTASLRMKD------  85
MUDCRAB             HLTKDL-SPVQ-YDLFLSHVFG---------------EKGIIAFGTRVTKEQA------  76
SCORPION            ICLRGTLSEKD-RSYVCSLILR---------------KEDGFLHFLEEAVNTPS------  76
SPONGE              LCVEQI-TESE-LAYSSSVLFN---------------PDNGILKFLHDVTTLEE------  69
CAPITELLA           ICLNDV-NASD-VDLAYSVIFN---------------HETGLIKFLKKIIQNDE------  74
DANIO               ECMITK-NENE-LVLQTSLLFA---------------KEEGLLSFLRRSLSTEKLGTTGV  86
MILII               DFRCSSSSDSQ-LALQSSMVFS---------------KDTGLLVFLRKSLRFEE------  81
BAMBOO              DLLH-NTHESR-LALHSSLVFS---------------KDEGLLIFLRKSLSNEE------  85
XENOPUS             ECLVSALGSSA-LDLNTSLIFS---------------KEFGLLAFVRKSLSSDE------  97
STERLET             ECMVSK-NENE-LVLQTSLIFS---------------KENGLLAFVRKSLNIED------  83
GAR                 ECLVVR-NENE-LVLRSSLLFS---------------KEDGLLSFLRKSLSSED------  77
LATIMERIA           ECLVTS-DENE-LALHISLIFS---------------KEIGLLIFLRKSLSSEE------  83
CAECIL              ECVTSS-GDSV-LALQTSLIFS---------------KEHGLLAFIHKSLGIEE------  83
SNAKE               SCVTSS-GDDI-LALQISLVFS---------------KENGLLSFIYKSLSVED------  81
CANARY              TCLASL-ASGE-QALHLSLVFS---------------QEYGLLVFIHRSLTIEE------  73
OSTRICH             DCVF----ALP-AALHISLVFS---------------QEYGLLVFIHKSLGIEE------  44
GECKO               TCVTSS-GDVA-RALQTSLVFS---------------KEDGLLAFIHKSLSTEE------  81
TURTLE              ACVTST-GDGA-RALQTSLVFS---------------KDNGLLVFVRKSLSMEE------  82
ALLIGATOR           PVVIRT-GDSA-QALQSSLVFS---------------KDQGLLVFIRKSLSIEE------  42
PLATYPUS            ECVLSA-GPAV-QALHTSLVFS---------------KEFGLPVFIRKSLDIEE------  77
TASDEVIL            EGVLCT-SPAV-LALQTSLIFS---------------KEFGLLVFIRESLSIEE------  78
HUMAN               ECVLSS-SPAV-LALQTSLVFS---------------RDFGLLVFVRKSLNSIE------  77
MOUSE               ECVLST-SSAV-QALQISLVFS---------------RDFGLLVFIRKSLSIED------  77
CRASSO2             ICINES-TDKD-IDLCCSVLFD---------------KRKGLVSFLSETVTKEE------  74
POMACEA             ICLHEI-SEKD-RDYCCSALFD---------------KDIGIIAFLQKVAAKDE------  70
TRICHOPLAX          LCLQTA-SDAE-KAYCSSALFG---------------QDYGVVTFLRKSIGLDD------  73
NEMATOSTELLA        HCSQLR-DESELGARCSSILFD---------------DKTGIIRFLHKTIANQE------  74
PRIAPULA            KCLQDI-SKRD-VDLTCSVLFS---------------EDRGVLIFLRRAIPLDE------  76
SOFTCORAL           YCIENI-NETQ-LAYCSSLLFN---------------QDDGLITFVKAVVQLDE------  73
PISTILLATA          FCLENV-SSSE-QAYYSSLLFS---------------GETSIVSFLRKVITLDE------  73
HEMICHOR            ICLRTT-SENE-LAYHCSVVFH---------------KETGILLFLKKTITIDQ------  75
BELCHER             ICLRHT-AERD-VAYCCSVLFQ---------------ESTGITAFLRKTVTLDQ------  76
STRONG              LCLNQT-RENE-LAFCRSELFQ---------------KETGIITFLQKAVSKDE------  75
STARFISH            LCLRQL-SENE-LAYCCSQLFN---------------KDNGILVFLNKAIPKDE------  75
                                    : ::                    ..  *
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                RYG70452.1
ARCHAEON          RDIVRAKVHAVKFLAVYVKKQIKYVM----IYAEKLAIDLIQLFKMEDSSEVKAALLLPV  141
MUDCRAB           --FVDVRNSTLDLIITLLMKDTKKII----KYVGDITNYTLFLYNADKSTKVCAHALEAF  130
SCORPION          --LKDSLIEALQFLNLFLINIGNKVV----QYGITVKDVVFSIFLRNQLAKVKILALSAL  130
SPONGE            --FASCKEELLKLLSNFVKNLSRRVL----SHIVPITDVCVFIFMREKSAKVKNATLNLL  123
CAPITELLA         --FEGCKCEILELLKTFISKFPGKVH----PYAVDVKDACLQLITRDRRARVKNNATPLL  128
DANIO             EILRETRVEIMNFLGAFLQRMSATVRGWEKNYAVELKDTCIVVYTKDKSAKCRNPALDLL  146
MILII             --FRDSREDVLKLLSEVVERIGEAVG----RYACDIKGTCVVVYTKEKAAKCKAAALDLL  135
BAMBOO            --FRDCREEVLKLITAFVEKIKETVG----PYALDIKDVCLVIYTKEKAAKCKVAALDLL  139
XENOPUS           --FKDCREEALKFLYTFLEKIGSNVQ----PYAMDIKTLCVIVYTKDRAAKCKIPSLELL  151
STERLET           --FRDTREEALKLLTTFLDRIAHKVNGWEKNYACDIKDTCLVVYTKDRAAKCKVSALELL  141
GAR               --FRDVREEVLKLLSTFLQRITQSVKGWERNYAVDIKETCLVVYTKDKAAKCRVPALSLL  135
LATIMERIA         --FRDNREEILKFLTAFVEKIGQKLN----PYACNVKLILFPVFFFF-----FIFIFFTY  132
CAECIL            --FRDCREETLKFLCIFLEKIGQKVQ----PYACDIKNTCVVVYTKEKAAKCKVPALELL  137
SNAKE             --FRECREEALKFILAFVEKIGPKIQ----PYAQDVKRICVTAYTKDRSAKCGIPALELL  135
CANARY            --FRDCREEALKFLCVFMEKVGDKIH----PYACNIKQTCLSVYIKERTAKCKISALELL  127
OSTRICH           --FRDCREEALKFLCAFLEKIGEKVH----PYACNVKQTCISVYTKERAAKCKIPALELL  98
GECKO             --FRECREEILKFLCAFLEKIGEKIH----LYAHDVKRTCIIVYTKDKSAKCRIPALELL  135
TURTLE            --FRECREEALKFLCAFLEKIGQQVH----PYAHDIKQTCISVYTKEKAAKCKIPALELL  136
ALLIGATOR         --FRDCREEALKFLCTFLEKIGQGVH----PYACDIKQTCISVYTKDKMAKCKIPALELL  96
PLATYPUS          --FRDCREEALKFLCIFLEKIGQKIE----PYSYDIKSVCISVYSKDRAAKCKIPALELL  131
TASDEVIL          --FRDCREEALKFLCIFLEKIGQKIE----PYSLGIKSVCTSVYTKDKAAKCKIPALELL  132
HUMAN             --FRECREEILKFLCIFLEKMGQKIA----PYSVEIKNTCTSVYTKDRAAKCKIPALDLL  131
MOUSE             --FRDCREEALKFLCVFLEKIDQKVM----HYSLDIKNTCTSVYTKDRTAKCKIPALDLL  131
CRASSO2           --FQTCKQKILEFLSEFVQRIGKKII----PYVFDIKDVCVSLFFRERLAKIKNLSVPVL  128
POMACEA           --FQSTKTNLLDFIGDFLQKVGKKLL----PYAIDIKEACVSAFSRDKYAKVKNSALGVL  124
TRICHOPLAX        --LDKCKEDLLKLITAYMEKIGGKIS----PYAVQIKDVCISLFTRDKAARVKNATFPPL  127
NEMATOSTELLA      --FVECKTELLKFLQSYLGQLNTRVN----PYAVAIKDICMKLLFQESSSKVKIETFLPL  128
PRIAPULA          --FKLAKKELLQLLHSFINKGQTRIL----TYAVDIKDTCLAVFSRDRQADVKNATFPLL  130
SOFTCORAL         --FAKCKEVILSFLAEYIAKVKTRIS----PYATDIKDICLKLFTKDKNARVKNETFEVL  127
PISTILLATA        --FQDAKIELLKFLQSYVMKMGKKIN----PYVVEIKDICLKIFSQDHSNKAKAETLPLM  127
HEMICHOR          --YVSSKERILEFVYNFMIRADKKIV----TYALDIKDVCLSLFTRDKMAKIKNRTFPIL  129
BELCHER           --YLPAKVETLSFLLAFLEKIGRKIQ----PHAVEVKEVCMAVFSRDRLSRVKCATFPVL  130
STRONG            --YGGSKVQTLEFLLGFVQKAKELVL----DHAKDIKDVCMSLYTRDKLAKVKAKTFPLV  129
STARFISH          --LKGSKEQLLEFLHAFLLKAGSRLL----ARTVEIKKICISAFMRDKSAKVKTKTFPVL  129
                            :.::   : .    :          :
```

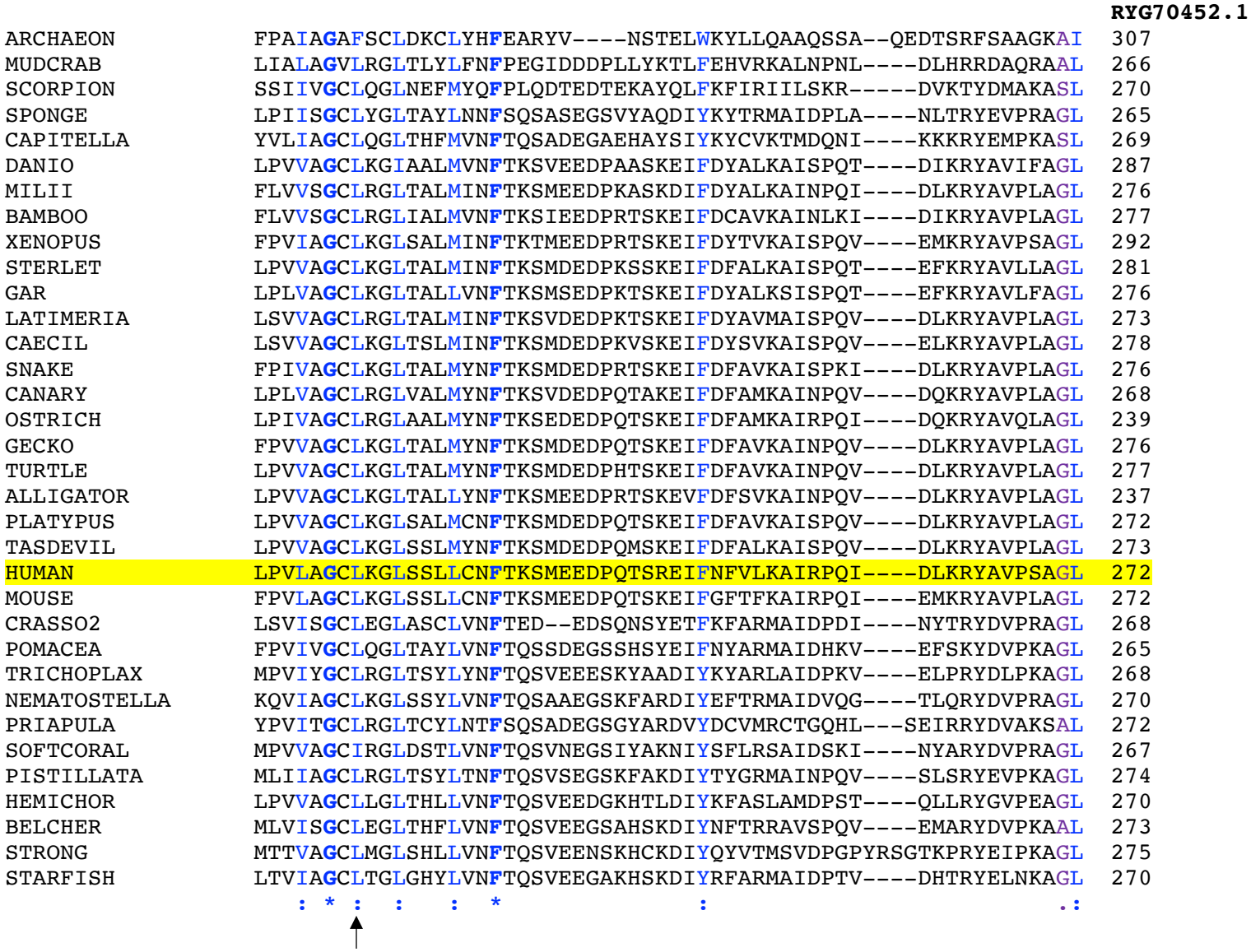
Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                RYG70452.1
ARCHAEON            KNILRPRIYSVEAIDAVAKLDDADDEVDDYDDCVPFDLDTFPLQSIYQVLVEEVRLNK-K  200
MUDCRAB             CLLLEKFSSHVSV----------------------Q-DINLHQLIEG---ICIQTQRY  162
SCORPION            IKVLELCSGAISS----------------------E-QFNLQKIVNKIIEYLAQASSK  165
SPONGE              INTLELCGKTEYS----------------------H-DLDIPKIADKFFQAALLPT-K  157
CAPITELLA           IELLKQTSGLPVA----------------------G-DLQVEGMIERLFKELIKSP-K  162
DANIO               IKILYLTKDSSIT----------------------Q-NLRIGDMFNKFYGELCQKH-K  180
MILII               ITLLHSKLSSSCL----------------------Q-QFKIGELFNKFYGDLSQKS-K  169
BAMBOO              LVLLHSK---VCL----------------------Q-EFKIGDMFNKFYGELAQKS-K  170
XENOPUS             IKLLQLLKNSIII----------------------E-EFKIGEIFNKFYGELATKS-K  185
STERLET             IKLLHITS-PCLL----------------------Q-EFKVGDMFNKFYGDLAQKS-K  174
GAR                 IQLLHGTKSSGVA----------------------Q-DFRVGDMFNKFYGELSQKS-R  169
LATIMERIA           LQLLQSTKSPHCI----------------------E-EFKVSEMFNKFYGELAQRS-K  166
CAECIL              IKVLQILKNSYEI----------------------E-ELKVKEIFNKFYSELGVKS-K  171
SNAKE               IKLLQKLQSSYAM----------------------V-DMKVGEIFNKFYGEIAIKS-K  169
CANARY              IKLLHTLQRSCLM----------------------E-EMKVGEIFNKFYEELAARS-R  161
OSTRICH             IKLLQNLRRSCLM----------------------E-EMKVGEIFNKFYGELATRS-K  132
GECKO               IKLLQNVRSACVM----------------------E-DMKVGEIFNKFYGELAVKS-K  169
TURTLE              IKLLQNLRSSFLM----------------------E-ELKVGEIFNKFYGELAARS-K  170
ALLIGATOR           IKLLQNVQCSSLM----------------------G-ELKVGEIFNKFYGELAGKS-R  130
PLATYPUS            IKLLQTLRSSRLM----------------------E-ELKVGGIFNKFYEELALKT-K  165
TASDEVIL            IELLKTLRSSRYM----------------------E-EFQLGELFSKFYGELALKT-K  166
HUMAN               IKLLQTFRSSRLM----------------------D-EFKIGELFSKFYGELALKK-K  165
MOUSE               IKLLQILRSTRLM----------------------D-EFKIGELFNKFYGELASKS-K  165
CRASSO2             AKVLELSVGSVNV----------------------Q-DLGIDKMINKFFMELTKSVSK  163
POMACEA             VKVLELTVGSPIR----------------------E-EMKIDNLVEKLFRELTKTS-K  158
TRICHOPLAX          LQLLSSKLHSSVV----------------------E-ELAISKLVDKYMSACKQPT-K  161
NEMATOSTELLA        IQLMQTKLESSII----------------------D-EMDIPKLIDRYFKACLQSS-K  162
PRIAPULA            IKVLQLCRGSQTQ----------------------A-KLDVPKLIDRYFNELTQSS-R  164
SOFTCORAL           LQLFELKFEPTIV----------------------E-KLDVKNIVEKYFSACSQST-K  161
PISTILLATA          AEILDVKLESSVV----------------------E-KLDVPKIFDKYFGACIQPV-K  161
HEMICHOR            NKLLELTANTPVA----------------------K-ELGVSKLIDKYFSQLMQPS-K  163
BELCHER             KKVLQLTIHSQLG----------------------D-ELRVSDMVDRMFLELTMKS-Q  164
STRONG              IELLKLTSGTRMD----------------------DEAMGVDAMLKKFFGELGQPS-K  164
STARFISH            IELLQRSASAQME----------------------A-DLDIPKMIELYFEQLMQPS-K  163
                       :                                    : :   : .
```

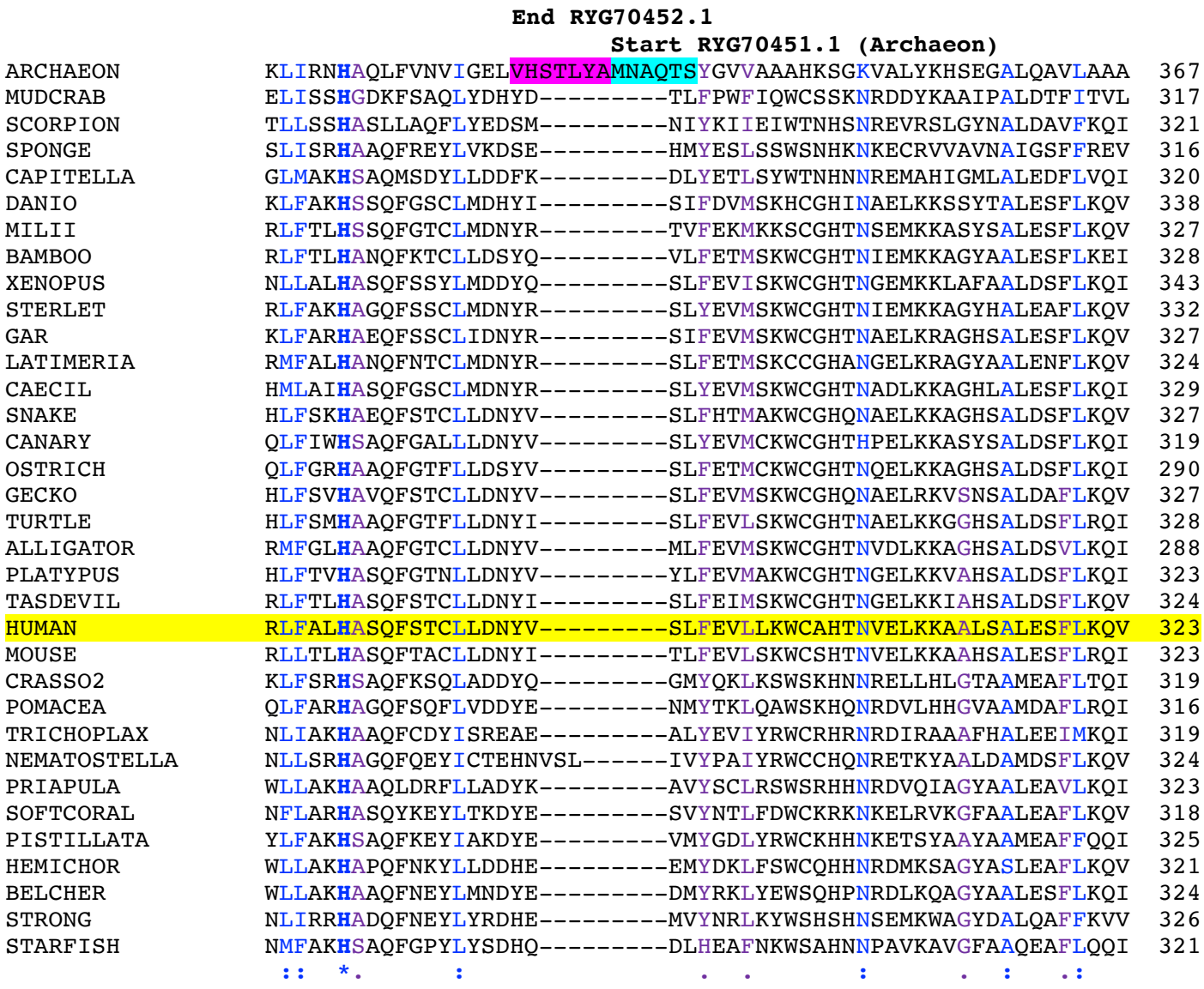
Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                RYG70452.1
ARCHAEON          LTKGVHREALATLGILVAVYPAAAFTVSVIDIILSLCDEALK------NAFNSRGK-DPD  253
MUDCRAB           KGSTILHHQLRTLGVLAKVYPENVRC--HSAMILKIYKDHIA------RHMGQ----KTD  210
SCORPION          ITPTVKQQAYYLLGISSRHYPDCMQL--CSERLLNWYLKDLK------FHTTSN--QKSE  215
SPONGE            HSATIRGGIYHLLGVLCEWFPEHLVK--ISSRLIDIYMSNLK------SEMTVKKTKKPE  209
CAPITELLA         PAASVKAHIFHLLGVIAELFPEKMVR--GSDKLLNLYMTTLK------QEIESKTH-EPE  213
DANIO             IPDTVLGCIYELLGVLGEVHPSEMVN--NSDKLYKAYLGELK------GQMTSTTK-EPK  231
MILII             FPDTVLEKVYELLGVLAEVQPTEMLH--NSEKLFCAYLNELR------VQMTSATR-EPK  220
BAMBOO            LPDTVLEKVYELLGVLAEVQPTEMLD--NSEKLYRAYLNELK------IQMTSATR-QPK  221
XENOPUS           LSDTVLEKVYELLGILGEVQPCEMTY--NSEKLFKAFLGELK------AQMNSSTR-NPK  236
STERLET           IPDTVLEKIYELLGVLGEVQPSDMLN--NSEKLYRAYLSELK------SQMTSATR-EPK  225
GAR               IPDTVLGNIYELLGVLAEVQPSDMTD--NSEKLYRAYLGELK------SQMTSTTR-EPK  220
LATIMERIA         LPDTVLEKVYELLGVLGEVQPSEMLH--NSEKLFRAFLGELK------TQMRSTTK-EPK  217
CAECIL            VPDTVLEKVYELLGVLGEVQPSDMLD--NSEKLFRAYLGELK------KQMTSTTR-EPK  222
SNAKE             VPDTVLEKIYELLGVLGEVQPSEMID--NSEKLFRAYLLELK------VQMTSATR-QTK  220
CANARY            IPDTVLEKIYELLGVLGEVQPSDMIN--NSEKLFRAYLRELK------TQMTSATR-GPK  212
OSTRICH           VPDTVLEKIYELLGVLGEVQPSDMIN--NSEKLFRAYLGELK------TQMTSTTR-VPK  183
GECKO             VPDTVLERIYELLGVLGEVQPSDMLE--NSEKLFRAYLGELK------TQMTSSTR-EPK  220
TURTLE            VPDTVLEKLYELLGVLGEVQPSDMVD--NSEKLFRAFLGELK------TQMTSATR-EPK  221
ALLIGATOR         VPDTVLEKIYELLGVLGEVQPSDMLD--NSEKLFRAYLGELK------TQMTSATR-EPK  181
PLATYPUS          ITDTVLEKIYELLGVLGEVHPSEMLC--NSEKLFRAYLGELK------MQMTSSTR-EPK  216
TASDEVIL          IADTVLEKIYELLGVLGEVHPSVMVH--NSEKLFRAFLGELK------TQMTSTTR-EPK  217
HUMAN             IPDTVLEKVYELLGLLGEVHPSEMIN--NAENLFRAFLGELK------TQMTSAVR-EPK  216
MOUSE             LPDTVLEKVYELLGVLGEVHPSEMIN--HSENLFRAFLGELK------TQMTSTVR-EPK  216
CRASSO2           LPASVKESIYVILGLLAEIYPEHMTQ--YAGKLVDIYLRALK------AEMTSKTK-KPE  214
POMACEA           LVPTVKGNIYFLLGVIAEVYPEDITQ--DSDRLVGLYVSALK------AEMTSKTK-KPE  209
TRICHOPLAX        YSSTVKSGMYSLLGTIAEKFPEYIMP--HAQQLLTIYLNTLK------SQMTGKNT-KLD  212
NEMATOSTELLA      QQSTVRFWLYTILGVFAEVFPEHMLG--NADRLISIYINLLN------SEMKSKGNKSPD  214
PRIAPULA          LTSTVKQGVYHLLGVIAESYPELMVA--YADKLISIYVNELK------NQMKSKTK-KPE  215
SOFTCORAL         KKSSVSYGIYSLLGTLAEYFPEYMVD--KADRLVQIYVGVLK------AE-MRKSG-KPD  211
PISTILLATA        HSSTVKYWLFSLLGTIAKVFPECVIS--HSDHLVKHYVSVLKLENLIPMQMTRKTK-KPD  218
HEMICHOR          LAATVKHGIYHLLGVFAQYYPELMTK--YSDRLLNVYMKALK------DQMLSKTK-QAE  214
BELCHER           TTATVKSGALSLLGVISEVYPDLMVQKDHPDRLLKVYISMLK------EQMESRTR-KPE  217
STRONG            LSQSVKLGIYQTLGAFGEYYPQLMMH--YSDRLFNVLVSTLK------QQMTTKTK-KPE  215
STARFISH          LSQTVKQGIYCLLGVLAEIYPVLMSG--YSERLLSVYIATLN------QQMTSKTR-KPE  214
                      :       **      *           :       :                .
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"



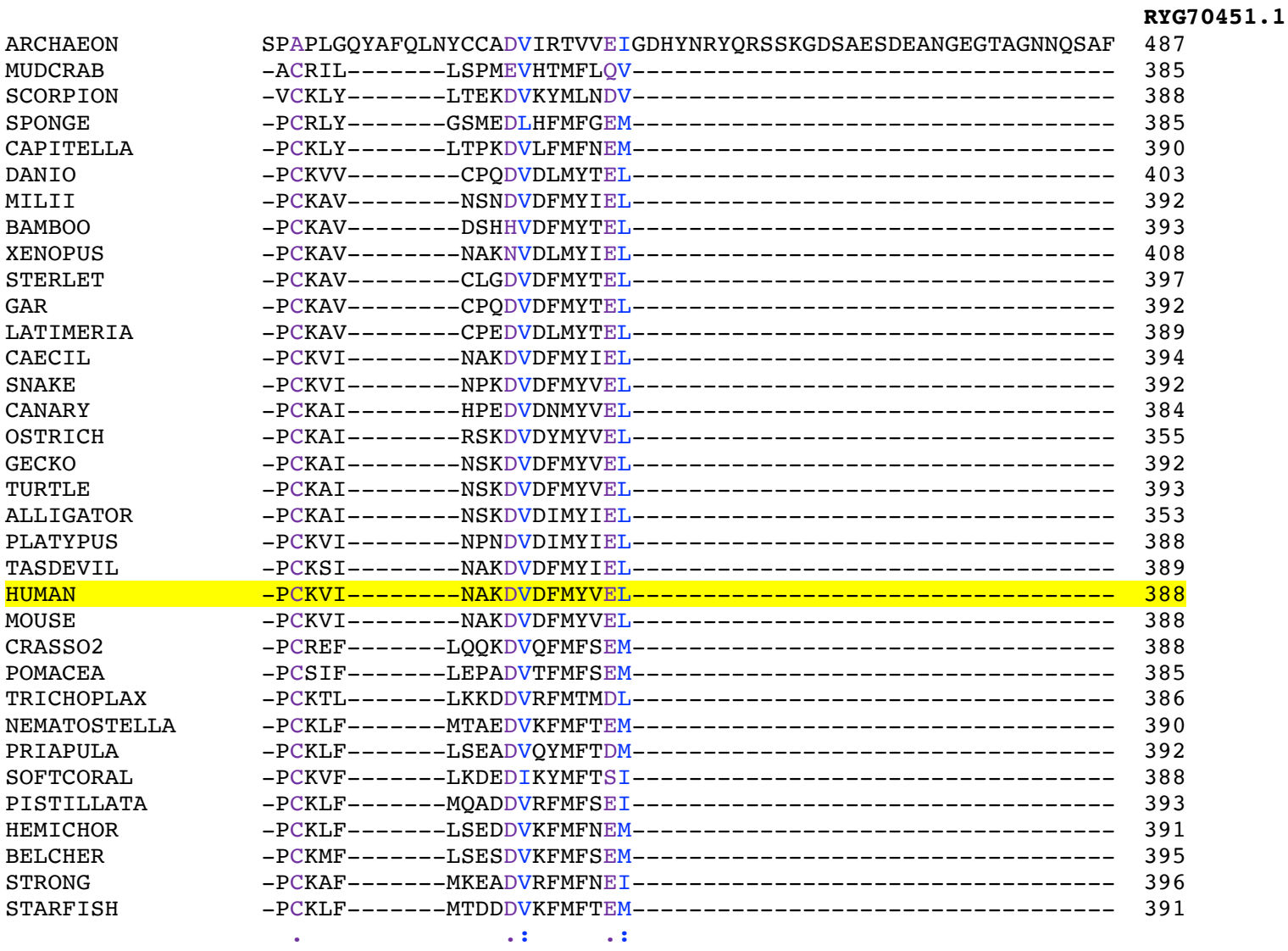
Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"



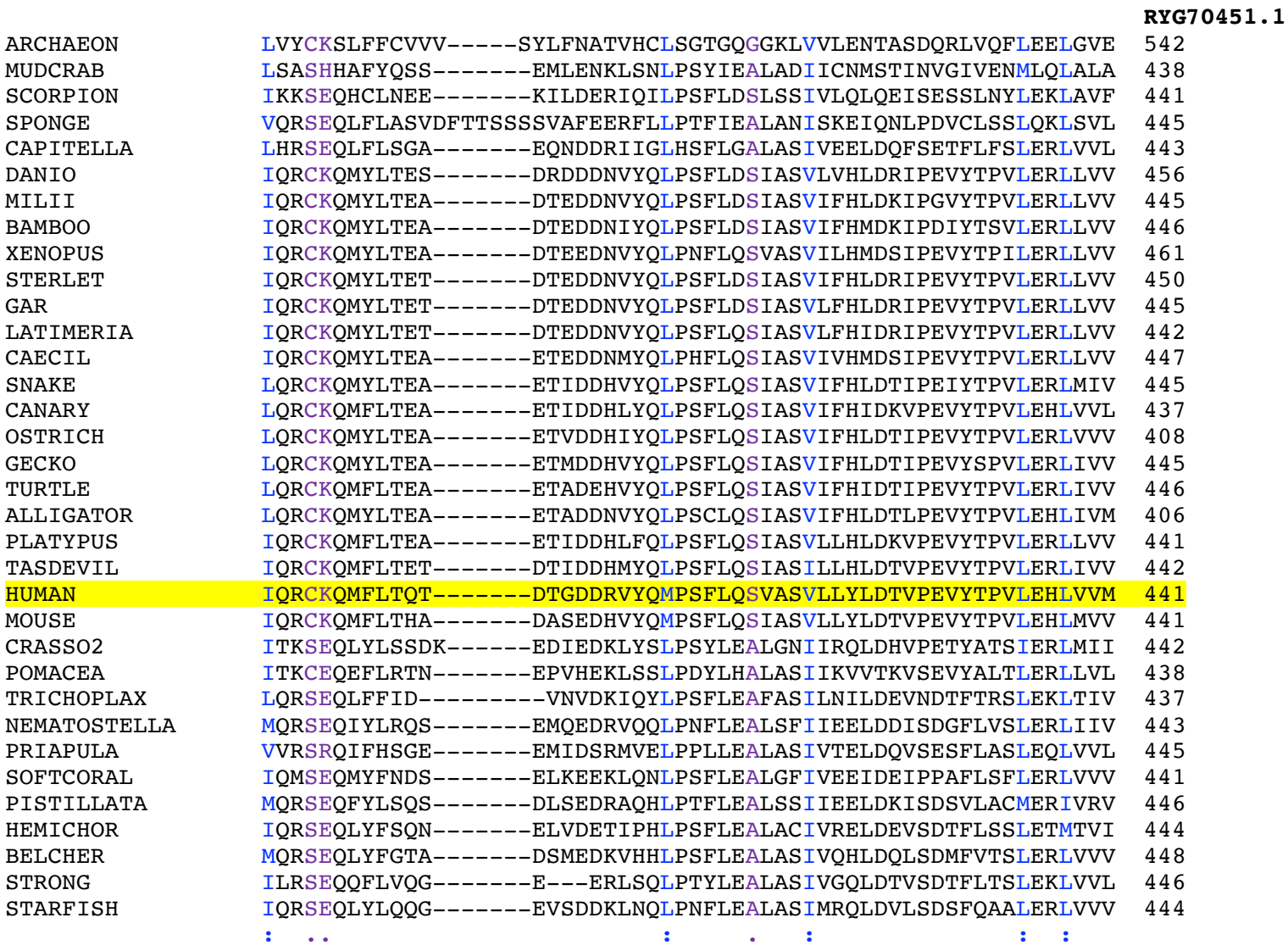
Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                RYG70451.1
ARCHAEON          ASYLVQNMHTGSNAVKKTCDMVNKLLEAHLKVLQDPGTLRSNSDDTVVALQGLNALSLAV  427
MUDCRAB           SNILELQSSED--KK--TVEIFKYLLQEYNKMLET----GKSTNQVSLAVKGYGLLSG--  367
SCORPION          SDMLEQNYEDS---C--KAEIFKFFIEKFQLMIKC----SENIRRVSTAIRGFGYFAK--  370
SPONGE            STQISDPSISR--EL--GISNYKFFMKCFRSLMNDP---DINHRLLSIAVKGYGHFAK--  367
CAPITELLA         SSALVTKVKEG-NRK--EGAVFKFFIQKFRDIMDNN---SSGSKEIAIAIKGYGYFAA--  372
DANIO             ATLVAENIELH-------KSKLKFFMQKFCAIIRTM---DSTNKELSIAIRGYGLFAA--  386
MILII             AIQVAENAHLH-------KDKLEYIMQQFYDIIRTP---ESSMKELSIAIRGYGLFAA--  375
BAMBOO            ALQVAEDAHLH-------KDKLQYFMQQFYSIIRTM---ESSTKELSIAIRGYGLFAA--  376
XENOPUS           AHLVASDAETH-------KNKLHFFMEQFYEIIRKM---DSSNKELSIAIRGYGLFAA--  391
STERLET           ALLVAENAELH-------KSKLEFFMRQFYTVIRTL---DSSTKELSIAIRGYGLFAA--  380
GAR               AVLVAENAELH-------KSKLKFFMQQFCSIIKTT---DSTNKELSIAIRGYGLFAA--  375
LATIMERIA         AAMVAENAELH-------KNKLEYFMKQFYGIIRTL---DSSNKELSIAIRGYGLFAA--  372
CAECIL            ASIVTHDAETH-------KSKLQFFMDQFYRIIRKL---DSSNKELSIAIRGYGLFAA--  377
SNAKE             SSMVAKDVEMH-------KSKLRFFMEEFYGIIRNM---DASNKELSIAIRGYGLFAA--  375
CANARY            SLMVAKDAELH-------KSKLRFFMEQFYGTIRRM---DSSSKELSIAIRGYGLFAS--  367
OSTRICH           SLMVAKDAELH-------KSKLQFFMDQFYGIIRRM---DSSNRELSIAIHGYGLFAA--  338
GECKO             SEMVAKDAEMH-------KSKLNYFMKQFYSIIRKM---DSSNKELSIAIRGYGLFAA--  375
TURTLE            SLMVAKDAEMH-------KSKLQFFMEKFYDIIRKM---DSSNKELSIAIRGYGLFAA--  376
ALLIGATOR         SLMVAKDAEMH-------KSKLKFFMEQFYSIIRKM---DSSNKELSIAIRGYGLFAA--  336
PLATYPUS          SLMVAKDVELH-------RSKLQYFMEQFYEIIRKI---DSTNKELSIAIRGYGLFAA--  371
TASDEVIL          SLMVAKDAEAH-------TSTLRYFTEQFYGIIRNV---DSSSKELSIAIRGYGMFAG--  372
HUMAN             SNMVAKNAEMH-------KNKLQYFMEQFYGIIRNV---DSNNKELSIAIRGYGLFAG--  371
MOUSE             SFTVAEDAELH-------KSRLKYFMEQFYGIIRNT---DSNNKELAIAIRGYGLFAG--  371
CRASSO2           SEVLVTKAREG--KK--EAAMFKFFVTRFKEIMENS---SASAKEMSLAIRGYGLLAA--  370
POMACEA           AEAITEKAKRG--IK--EGGIFKFFVQVFQTTMQNS---SASSKEVSMAVRGYGLFAA--  367
TRICHOPLAX        AEYLVNEND----AA--NINIFKFFLKKFRSIIDSG---SSDAKELAIAIRGYGYFAA--  368
NEMATOSTELLA      SEYIVLDEA-----E--AVNPKEDFIQRFRAIIDSD---SSTTQQMSIAIRGYGFFAK--  372
PRIAPULA          ASVLVEGGEET-RQR--DTIVFTFFVREFRTIIEA----GTDTRDVAIAVRGYGSFAT--  374
SOFTCORAL         AECLVTEDFET-TVE--CGDIFKYFIKEFRRIINSN---ESLTREISIAIRGYGYFAK--  370
PISTILLATA        SLYFVGRHG---DKS--DLAMFMYFIKTFRRIIDSV---LSDTRQMAIAVRGYGYFSK--  375
HEMICHOR          ASMLVEEGNKD-KRN--KTTIFKAFIRKFRSIIDNR---ESGTREICIAIKGYGLFAA--  373
BELCHER           SDMLVARHEKENNKA--DLAVFKFFIREFRTIIDTT---EAGTREMSIAVRGYGFFAA--  377
STRONG            SHMLVENADKK-RSS--DVAVLKYFIKSFRSTIDDA---SSSSKSLSTAIRGYGVFAA--  378
STARFISH          AEILVERAAKR-DAS--DMAVFRFFVKRFRDIIDNP---QSDTRALSSAVRGYGYFAA--  373
                  :  .                    :   .   :              *::* . ::
```

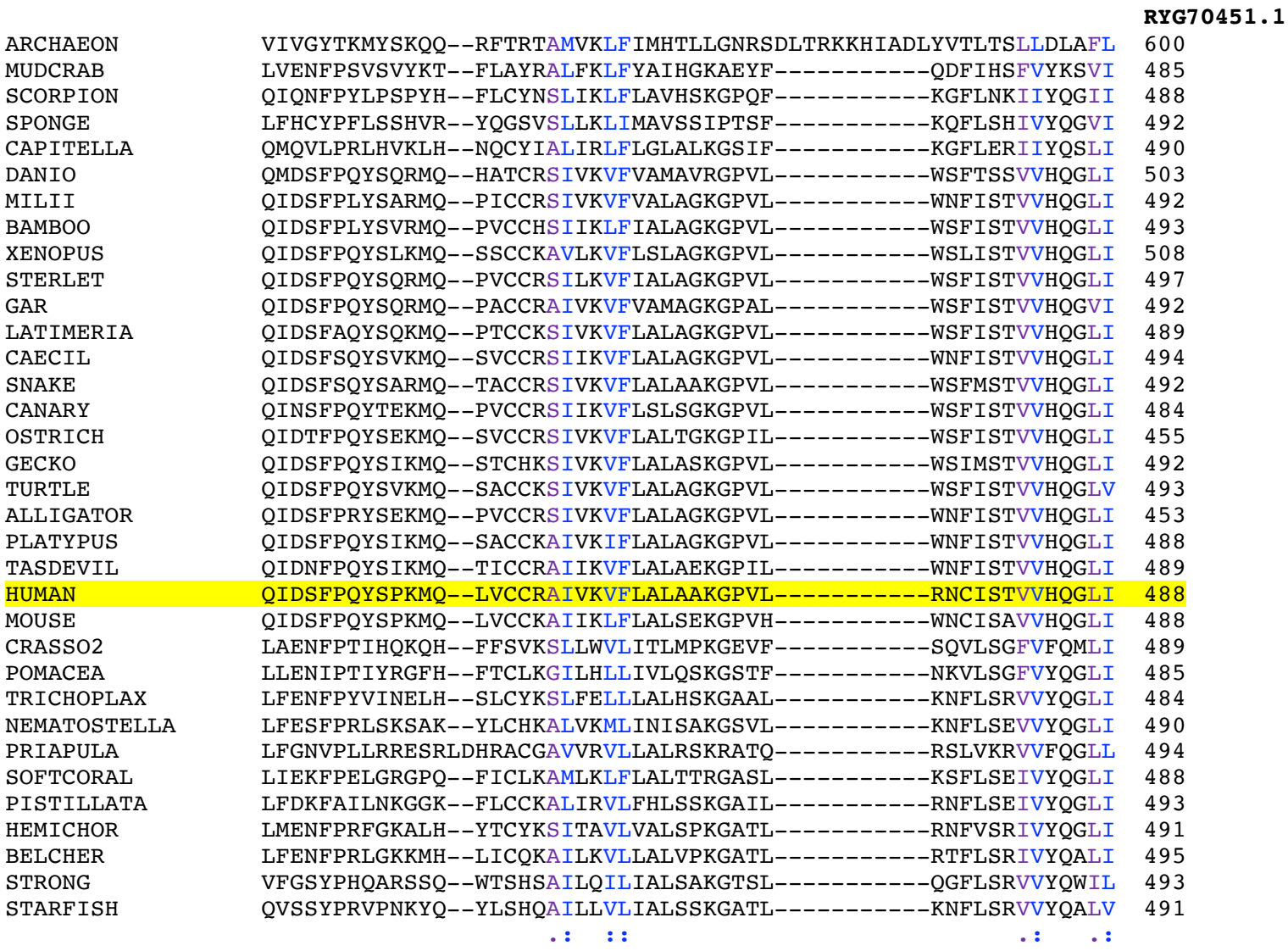
Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"



Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"



Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"



Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                  RYG70451.1
ARCHAEON          RTLARKESTD----------------HIAADHARLSSYSVFSVEEDRLVFVYSSLWHALL  644
MUDCRAB           HTCSHAPEIDSLKKESELW-KESNDSEESGGKWEGFKKE------AVTYKNYLPLWKAIM  538
SCORPION          RTCSYPVRFEIEAREENMS----------GDNLELKNPR------EITSKSYSSLWENLL  532
SPONGE            RSCSLPVVIEAVQGDDSAVVT--------AAPLADSNDK------VMSYLDYVQLWIQLI  538
CAPITELLA         RSCSHPIVLESQEAKSEN-------------VDEVNLKV------DVSYQDYLPMWKALL  531
DANIO             RVCSKPVLQSDERGVSSGV-----SQSEDSTLVRSGKWK------VPSSKDYLELFKGLL  552
MILII             RVCSKPVLLPGEGTGRSES--GL-QQQSASEVMWTGKWR------VPSYKDYLDLFRSLL  543
BAMBOO            RVCSKPVLLPGEEMTKAEPWSSA-QQSLSNGNMGTGKWR------VPSYKDYLELFRSLL  546
XENOPUS           RVCSKPVVLAQDG--KEGSEAE---TAAATGEVRAGKWK------VPTYKDYLDLFRNLL  557
STERLET           RVCSKPVVLTGEEGG---QGGG---QPVEKGQVHTGKWK------VPSYRDYLDLFRNLL  545
GAR               RVCSKPVLLTEEEGAAQGAEGG---RSAGAGQVRTGKWK------VPSYRDYLDLFRSLL  543
LATIMERIA         RVCSKPVPLSTEGIGKGGLQSEEEADPAAPGEVRTGKWK------VPSYKDYLDLFRNLL  543
CAECIL            RVCSKPVTLGKEGSGKGSPGSE---EPPVAEEVRIGKWK------VPTYKDYLDLFRSLL  545
SNAKE             RICSKPLVFSMDFGGKNISKSE---EYDSSGEVRTGKWK------VPTYKDYLDLFRTLL  543
CANARY            RIFSKPITFSKDFSVKETSGTE---EAFEAGEVGTQRSK------LPTYKDYLYLFRSLL  535
OSTRICH           RIFSKPITFSKEYFGKKTSGSE---ESPAAGEAGAGKWK------VPTYKDYLYLFRSLL  506
GECKO             RVCSKPLAFLRENSGTGVSASE---EHPASGEVRSGKWK------VPTYKDYLDLFRSLL  543
TURTLE            RVCSKPITFSREIFGKEVSKLE---ESTTAGEVRTGKWK------VPTYKDYLDLFRSLL  544
ALLIGATOR         RVCSKPIVFSREFDGKGASKSE---EPPAVGEVRTGKWK------VPTYRDYLDLFRSLL  504
PLATYPUS          RVCSKPVPFLKEAYGRDASESD---DSSAFGEVRVGRWK------VPTYKDYLDLFRSLL  539
TASDEVIL          RVCSKPVILQKEAFGKEVSESE---EYPSSGEVKTGKWK------VPTCKDYLDLFRNLL  540
HUMAN             RICSKPVVLPKGP----ESESE---DHRASGEVRTGKWK------VPTYKDYVDLFRHLL  535
MOUSE             RICSKPVVLQKDV----ESRSD---NRSASEEVRTGRWK------VPTYKDYVDLFQHLL  535
CRASSO2           RTCSHPPLIETEDMTES------------N--QSEQTGT------KVTFKDFIELWDTLF  529
POMACEA           RTCSHPVVMGADENQEI------------STAETDLTVK------QITYKDYLEVWSGLL  527
TRICHOPLAX        RTCSHPVYVETDSDLNIS-----------QDSVILETGP------RISYKDYISLWKNLI  527
NEMATOSTELLA      RTCSHPVLLDEGPDVDKQ-----------VGVVTGSRSD------QVTFKDYLPLWEHML  533
PRIAPULA          STCSHPVAMETSSVFS-------QNADDVDDDFQERDPR------NITYIDYMDMWRHLL  541
SOFTCORAL         RTCSHPVLLDEGVDAM--------------EGVTEFDVR------HISYKDYLELWECFL  528
PISTILLATA        RTCSHPVILKEVNGESTIME---------EREVYEGSTP------NTSLKDYLELWEYLL  538
HEMICHOR          RTCSHPVVLEGEMYDV-----S--GDE--TSDELLIDAR------KVSYKDYLDLWNHLL  536
BELCHER           RTCSHPNVIEGVTAEDEDLPVA-SGEEGGEQQPQQPPVK------RFSYRDYLELWGNLL  548
STRONG            RTCSFPVLLESGGD--------E-GEEQRSDEMEIEQDSR------RVSYKSFMDLWTRLL  539
STARFISH          QTCSHPVVLDGSPSID--HPVL-GNDDQDTEADILADAR------HITYKDYVKLWASLL  542
                     :                                                :  ::  ::
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Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                RYG70451.1
ARCHAEON          KPTDKTLRLFCLDMLGLSF------LDVVKQRLVQWLFSKCMSTIKSLQLTYSKAEEALQ  698
MUDCRAB           MPEKVSYV----KIPGV----STTILTEISSKLYSEYITSTIEIAEKLDLSTFKQEEIET  590
SCORPION          YIVRNKEL----NHIGI----SLEDRHNLLQLIYDEIISVVLTLLKKLDLATTHSMQDSE  584
SPONGE            DYKKLKGM----GMDF-----DLELRQSIHQLVYSEFIQSLLNILRKLDFTTASTTEDGI  589
CAPITELLA         TAGKLKAL----GQYNI----TAEQHRVLASAIYDELLSAMLKMISRLDLSSNSTDSESQ  583
DANIO             DCENLKDT----GFVDGAPAAKNYNLRDLNRHLYDALVQSVMKIVEKLDLSVQKVSAADE  608
MILII             NCGKMKEF----GLV-DTLQMINLPLQSLNRLLYDEFIKSILKIIEKLDLSVEKQNQREE  598
BAMBOO            DCGRMKES----GLIYETFQMFDSPLKSLNRLLYDEFIKSVLKIIEKLDLSVDKQSQNEE  602
XENOPUS           RCDQLKDS----IFSDEIFSTVNSPLQSLNRLLYDELMKSILKIIEKLDLSLQKQDTGQE  613
STERLET           ECDKMKDT----GFVDGAFDVRSSSLHSLNRLLYDELIKSILKIIEKLDLSVQKQSADEQ  601
GAR               DCDLMKDF----GFLEGVFESQSAPLQSLNRLLYDELVKSILKIIEKLDLSVQKQNPDEL  599
LATIMERIA         ECDKLKQS----ALVDETFGVVNSPLQSLNRLLYDELIKSILKIIEKLDLNVQKQKVGDQ  599
CAECIL            DCDKMKES----IFSDEVF-SVNSPLQSLNRLLYDELIKSVLKIIEKLDLTVEKQSVGEQ  600
SNAKE             GCDTMKNI----LLADEVCLTEYSPLQSLNHMLYDELIKSVIKIIDKLDLTVQKQNINEE  599
CANARY            SCDTMKES----VFEDANFLTEKAQLQSLSRVLYDELIKSVLKIIEKLDLTVQKLDISEQ  591
OSTRICH           NCDTMKES----VLEDENFLAANSALKSLSRLLYDELLKSVLKIIEKLDLTVQKLNVNEQ  562
GECKO             SCDTMKDS----LLADETCLMANSPLQSLSRLLYDELIKSILKIIEKLELTVQKQNVNDA  599
TURTLE            NCDTMKES----VLADETFLIANSPLLSLNRLLYDELIKSILKIIEKLDLTVQKLNVSEQ  600
ALLIGATOR         NCDAMKES----VFADENFLTVNSPLQSLNRLLYDELIKSILKIIEKLDLTVQKLTFSEQ  560
PLATYPUS          NCDEMKDS----QL-DETFLIVNSPLQSLNHLLYDELIKSVLKIVEKLDLNVEKQNTGEK  594
TASDEVIL          SCDQMKDS----LLADETFLLVNSPLQSLNRLLYDELIKSILKIVEKLDLKLEKQNVGNQ  596
HUMAN             SSDQMMDS----ILADEAFFSVNSSSESLNHLLYDEFVKSVLKIVEKLDLTLEIQTVGEQ  591
MOUSE             GCDQMEDF----ILGDETFLFVNSSLKSLNHLLYDEFIRSVLKIVEKLDLTLEKQTVGEQ  591
CRASSO2           NSPRIKEF----SVADI----SVEVRLALTEAVYDELINSVLRMLGKLDLTSQSSTEVAQ  581
POMACEA           ESGKIKDL----IQDGI----GFAERDQLTHAVYNELMQAILKVISKLDLTSTTQRESE-  578
TRICHOPLAX        QATEIKGL----TLITT----DREHIIYVQRSLYNELLHSLQRILLKLDLTSSQQTTIE-  578
NEMATOSTELLA      DKTKFKMY----LLFQSLSLSDIEKRESLHELVYDELVGAILRIIHKLDLTSTKHGQQDL  589
PRIAPULA          GSDKMKGL----NELGV----SMSDRKALTCCVYDEIVTSLMKIVGKLDLSTSKSTDPSQ  593
SOFTCORAL         DGGQYKDQ----SIMPK----VSSLTQDIHRAIYDELIQAILKVAHKLNLSSFRDVETQD  580
PISTILLATA         DKDKLKDE----SLLGK----QLEERKVMHGLVYDEMIRGILRIIHKLDLSSSKGSSAQE  590
HEMICHOR          DSSQLRI-----TDIGL----SPQDCKVLHNIVYDELIAAIIRILGKLDLSSNKDGQLGN  587
BELCHER           DSSRLKEL----SQWGV----AVADRQAMHRMLYDELVTSVLKVIDKLDLTTSKQVETGN  600
STRONG            DSKFIKTS----EAHGS----SYAERLNIHTMIYNELIGGILKVLKKLDLSSNKHNEEEA  591
STARFISH          DSTHVKEV----QAMGM----NYADRRKIHIILYDELIFSILKILSKLDLTSNKDTTELQ  594
                                       :   : .  .         *::
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                RYG70451.1
ARCHAEON          KQDTYNYADFVFV---NVMEMSQKLPLLSGFYRMLSCLLIHLEDL-----------LACG  777
MUDCRAB           LQYEDQLQGHVSRLCWFFIRCSSEQPLVSAHYTSLTTILVCAQKMRYFEKTK--------  684
SCORPION          SKHNELFEKWILIFGLEIIQFINKNPYISGFYKLITVCLTICKKTRYFQHVKKLKTKEE-  691
SPONGE            SVSLSLFTPWILTFSQEVVSLATRYPLVSGFYKLLTVCLSICNKTHFFDVHDLSGQGTGD  698
CAPITELLA         VTQTQKFSSWVFPFGHQLILQSSKLPLVSGLYKMLTVCMQVASQISYFKEMNRQLKIETS  685
DANIO             SRNPEYFAQWMHPLCHELILQSIRFPLVSGFYKLLSLSMGIAKKTQYFQDVKQCP-KQVG  709
MILII             ERHEEFFDQWVYRFGYELILRSTQFPLVSGFYKLLSATMKIAKKINYFKGVSTNTWKQCH  702
BAMBOO            EKHTDFFEHWVYRFGHELILRSTQFPLVSGFYKLLSVTMKIARKIKYFEGVNPKTRKQCP  705
XENOPUS           KEHIEYFESWVYVFGYELVLQSTRLPLISGFYKLLSVVMKNAKKSRYFEGFTSKIYKKAP  716
STERLET           KEHVDFFEQWVYGLGHELILQSTRFPLVSGFYKLLSVSMKIAKRIKYFQGVSPRSCKTSP  705
GAR               KKHVEFFEQWVYPLGHEIILQSTRFPLVSGFYKLLSVAMKIAKKIKYFKGVSPKSFQPNP  702
LATIMERIA         EKHVEFFEPWMYGFGHEVILQSTRLPLVSGFYKLLSVSMKIARKIKYFEGVSSKSCKQNS  703
CAECIL            EKHIEFFEIWVYTFGYELILQSTRLPLISGFYKLLSVAMKNAKRTKYFEGVSPKSHKKCP  704
SNAKE             DKHIKYFEPWMYSFGYELIIQATHLPFISGFYKLLSIAMKIAKKTKYFAGVSPESTKKYP  703
CANARY            EKHVEYFHPWVYSFGYELIVHSTRLPLISGFYKLLSVTMKIAKRIKYFEDISPRSLRRCP  694
OSTRICH           EKHVEYFNPWVYSFGYELIIHSTRLPLISGFYKLLSVAMKIAKKIKYFEGVSPKSLRKCP  665
GECKO             EKHIEYFEPWVYSFGYELIIQSTRSPFISGFYKLLSIAMKIAKKIKYFEGVAPKSKKKCP  703
TURTLE            EKHVEFFEPWMYSFGYELIVQSTRLPLISGFYKLLSVAMKIAKKIKYFEGVSPKSYQKCP  703
ALLIGATOR         KKHLEYFKQWVYSFGYELIIQSTRLPLISGFYKLLSVVMKIVKKIKYFEDVSPGTQKKYP  663
PLATYPUS          EKHVQFFEPWVYSFGYELILQSTRLPLISGFYKLLSIAIRNAKKMKYFEGVSPRSLKKSP  697
TASDEVIL          EKHIQYFEPWIYSFGYELILQSTRLPLISGFYKLLAIAIRNAKKLRYFEGLSPKSHKKSP  700
HUMAN             EKQAEFFEPWVYSFSYELILQSTRLPLISGFYKLLSITVRNAKKIKYFEGVSPKSLKHSP  695
MOUSE             RKHVGFFEPWVYSFAYELILQSTRLPLISGFYKLLSIAVKNARKIKYFEGISPKSLKHSP  694
CRASSO2           EKHYKMFGKWLFLFSHTLILQSTEKPLVSGYYKLLAVSMKIANKLNYFQGMVSLSPVKK-  685
POMACEA           PKHFQYFEKWVFTFTHTVVVQSTEFPLVSGFYKLLAVTMKIANKLEYFKDIAVENSFKK-  681
TRICHOPLAX        TTRTEFFLPWIFPFGKNLVLLSTRLPLVSGFYKLLEICMTISSSLSYFEDLNIETVTKCT  677
NEMATOSTELLA      GQSTDSFGRWVYVFGRDLIVSSSRFPVVSGFYKLLEVCMKICKRLRFFQYEVTA------  687
PRIAPULA          TNQTALFRRWIYTYGHEVILLSTRWPVVSGLYKLLTVCLSICSSLQYFKAMRKVNDSQLH  702
SOFTCORAL         KTKTKWFENWIYTFGKELVVLSARFPLVSGFYKLLDIVMKISRKLDYFKGMTLKDVSTGC  692
PISTILLATA        NYCVTLFERWIYMFCRDIIIMSSRFPVVSGFYKLLEVCMKMCEKLSFFKNIKAEKPDLK-  703
HEMICHOR          KRCPYYFERWVYTFGHEVIVHSTRLPLVSGFYKLLSVCMTISQNIGYFQGINENAKVAVP  699
BELCHER           HHHPEYFQRWVFTVGHALILHSTRLPLVSGFYKLLSVCMTICTKVKYFKDLDTKLLSFS-  704
STRONG            TRQIHLFDPWVYRFGHELIQLSSQLPLVSGFYKLLTICMTMSRKTAFFKEVNPNVTFRTE  696
STARFISH          ANQPALFKQWVYRFGHEVILLSCRLPLVSGFYKLLTVCMNICTQIQFFKCIKPSDLSSQ-  697
                            :      .:    . * :*. *  :   :
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                RYG70451.1
ARCHAEON          IH-------------------ANNEQASVVSCMSQISIFVMK----LQENLVASPNDYN  813
MUDCRAB           -------------------------DPEVETLIHLITSYVKD--------VLQRCRQLR  710
SCORPION          ----ISM-----------------SEKDCLIAFELFAKFSRE--------VVIYLQQFK  721
SPONGE            --DDVAM---------------ETEERTDRQSCYFLFSSFIKE--------VVVQMQQYK  733
CAPITELLA         DS--IKMEMDE----------EFRTSTAQEEACFMLFTKFAKE--------VMTRLRQYK  725
DANIO             -------------------------GSTMENACFSLLAKFGKE--------VCVRMKQYK  736
MILII             -------------------------TDPEKCACFALFGKFGKE--------VTIRMKQYK  729
BAMBOO            -------------------------KNPEKFACFALFGKFGKE--------VAIRMKQYK  732
XENOPUS           -------------------------EDPERLSCFALFAKFGKE--------VSSKIRQFK  743
STERLET           -------------------------EDPDKYACFALFAKFGKEVSTILGKEVSVRMKQYK  740
GAR               -------------------------QDPEKYACFALFAKFGKE--------VSVRMKQYK  729
LATIMERIA         -------------------------LDPEKYACFALFAKFGKE--------VCARMKQYK  730
CAECIL            -------------------------KDPERFACFALFAKFGKE--------VSAKMKQYK  731
SNAKE             -------------------------EDPERSSCFALFSKFGKE--------VTTKMKQYK  730
CANARY            -------------------------EDPEKSSCFALFVKFGKE--------VAAKMKQYK  721
OSTRICH           -------------------------EDPEKSSCFALFLKFGKE--------VTAKMKQYK  692
GECKO             -------------------------ENPEKSSCFALFAKFGKE--------VTAKMKQYK  730
TURTLE            -------------------------DDPEKSSCFALFAKFGKE--------VTAKMKQYK  730
ALLIGATOR         -------------------------EDPEKSSCFALFAKFGKE--------VAARMKQYK  690
PLATYPUS          -------------------------EDPEKYSCFALFAKFGKE--------VAVKMKQYK  724
TASDEVIL          -------------------------EDPEKYSCFALFAKFGKE--------VSIKMKQYK  727
HUMAN             -------------------------EDPEKYSCFALFVKFGKE--------VAVKMKQYK  722
MOUSE             -------------------------EDTEKYSCFALFAKFGKE--------VSVKMKQYK  721
CRASSO2           ---EVKMEVDS----------DQKADIHQRATCFQLIQKFTKE--------VLVRMKQYK  724
POMACEA           ---EEQMDVDE----------TGIDGQTEKHLTYILIKKFSEE--------VLVRMKKFH  720
TRICHOPLAX        IN-----------------AAAEAESIDKYLCYLLYYKFYKE--------VLVRLKQYK  711
NEMATOSTELLA      -D-----------------DMEIVDTSDCTNCFILFRKFIKE--------VLIKMKQFK  720
PRIAPULA          ---SEAMET----------DSPDAVDNAEILNCFTLFKKFSKE--------VLVKLKMFR  741
SOFTCORAL         VD---DM------------ETDQLDFSDCRNCFILFHKFAME--------VVVRMKQYK  728
PISTILLATA        ---NENL------------NLEIVDTSDCMKCFVLFHKFTKE--------IVVRMQQYK  739
HEMICHOR          RHIEEKAS-----------TKDMCTLADKVAAFHLFKKFTKE--------VLIRLKQYK  739
BELCHER           ---EESMDTEG----------RDRPSEGQACFTLFRKFVKE--------VLVRLKQYK  741
STRONG            VNEEEPMDVDDDSESIATRTTPSNVSLSDKQACFILFSKFSKE--------VLIRLKQYK  748
STARFISH          ---EDSMDIDL-----NFSSSSSCVSASDRCICFTLFAKFSKE--------VLVRLKQYK  741
                                                  :  .        :    .  .
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                RYG70451.1
ARCHAEON          NELLQSIVKVILSLPIECLSIDCM------YITLHISLSSNIHLNKCIAMLNKHFTFDPK  867
MUDCRAB           DQLLASCLTLILKLPVCIVIEIFPRLIVPLQMALHLGVSYLPLAEVCIAALCKWTHILPS  770
SCORPION          DELLASCIEVILSLPTEIVESEINILIPAVQISLQLGLSYLPLAMSCLDALETWLYSLPS  781
SPONGE            DDLLASCLHLILVLPKEMVVSDFKELIPAIKLALRIGMGYLPLAKSVMEALEKWTLYIVE  793
CAPITELLA         DDLLASCLGFILALPREIIALDVTTFVPALQRSLEIGRSYLPLARTSLNTLESWSKSLPP  785
DANIO             DELLAACLMFILSLHPGMVALDIKAYIPALQAALRLGLSHAPLATAALDALESWSSFIPA  796
MILII             DELLVSCLNFVLSLPHDIIELDIKAYIPALQAAFKLGLSHTPLADAGLDALEDWSAHIPK  789
BAMBOO            DELLASCLTFVLSLPYDIIELDIKTFIPALQTAFKLGLSHIPLADAGLDALEHWSTRISK  792
XENOPUS           DELLASCLTFVLHLPHDIIMMDIKAYIPALQTAFKLGLSCPPLADVGLNALQYWSTNIPS  803
STERLET           DELLASCLTFVLSLPHDIVALDIKAYIPALQNSFKLGLSHTPLANTGLYALENWSQFIPK  800
GAR               DELLASCLTFVLSLHHDIVALDIKAYVPALQTALKLGLSHTPLASAALDALEEWSSRISQ  789
LATIMERIA         DELLASCLGFILSLPHTIVELDVKAYIPALQMAFKLGLSYTPLADSGLDALEEWSNRIPK  790
CAECIL            DELLASCLIFILSLPHDIIMLDIKAYIPALQTAFKLGLSYSPLADAGLDALEDWSAYIPQ  791
SNAKE             DELLASCLTFVLSLPYNIIMLDIKAYIPALQNAFKLGLSYTPMADVALDALEDWSSYIPR  790
CANARY            DELLASCLIFLLSLPHDIIMLDIKAYIPALQNAFKLGLSCTPMADLGLDALEDWSAHIPR  781
OSTRICH           DELLASCLSFLLSLPPDIIMLDIKAYIPALQNAFKLGLSCIPMADLGLDALEDWSAHIPK  752
GECKO             DELLASCLIFVLSLPHDIIMLDIKAYIPALQNAFKLGLSYTPMAEVALDALEDWSAHIPR  790
TURTLE            DELLASCLTFVLSLPHDIIMLDIKAYIPALQNAFKLGLSYTPMADEGLDALEDWSAYIPK  790
ALLIGATOR         DELLASCLTFVLSLPHDIIMLDIKAYVPALQNAFKLGLSYTPMADVALSALEDWSSHIPK  750
PLATYPUS          DELLASCLTFVLCLPHDIIMLDIKAYIPALQMAFKLGLSYPPLADVGLNALEEWSIYIPR  784
TASDEVIL          DELLASCLNFVLCLPHDIIELDIKAYVPALQMAFKLGLSYTPLAEVGLNALEEWSLYIPK  787
HUMAN             DELLASCLTFLLSLPHNIIELDVRAYVPALQMAFKLGLSYTPLAEVGLNALEEWSIYIDR  782
MOUSE             DELLASCLTFVLSLPHDIIELDVRAYVPALQMAFKLGLSHMPLAEIGLHALKEWSVHIDK  781
CRASSO2           DDLLAACLTFILTLPKEIVSEQMSSVVPAIQLTLSIGLGYLPLAMIALDALDYWSDTLPA  784
POMACEA           DDLLASCLTLILTLPKEIIAQQMSKIVPAIQLTFSVGLSYLPLAEVGLDSLVWWSQVLPP  780
TRICHOPLAX        DDLHVSCLSLILALPYQLIQDDMALIIPAIKVSMNIGLSYLPLANAAIDALERWSSDLPQ  771
NEMATOSTELLA      EDLLSSCLSLVLSLPYEIVAVDVAAIVPALELTFKLGLSYLPLAQAGLAALEEWNASLPG  780
PRIAPULA          GDLLVACLQLVMALPYEIVVDIVPEIVPAVQVALKIGLSYPPMAHTTLDALEMWVANLPA  801
SOFTCORAL         DDLKSSCLQLVLSLPNELVLCDIDIIIPTLKTAFKLGLGFLPLAEAALDALDTWTAELPS  788
PISTILLATA        DDLLFSCLLVVLSLPLELVTLDLVSSVAALKLTFKLGLSYTPLAEAGLDALESWTTALPA  799
HEMICHOR          DDLLASCLFLVLALPHEIIASDVAAIVPALQTTFRIGLGYLPLAHAGLDALETWAFRLQH  799
BELCHER           DDLLASCLLLVLSLPHQIVQSEISTLVPALQTTFRLGLSYLPLAHAGLDALERWLLNLPR  801
STRONG            DDLLASCLFLILSLPHQVVENQVHDVIPALKTAFKLGLSYLPLAESGLSALQAWIRYIPS  808
STARFISH          DDLLASCLLLVLSLPHEIVQAEVAHLVPALQMTFQLGLSYLPLAETGLEALERWMLHLLP  801
                   :*  : : .:: *    :             :: :. .        :  *
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                RYG70451.1
ARCHAEON          ----KFLNGTATSLLPLLSKYIVPISMENLSVNERHE----------YVSIGRK-KLKTH  912
MUDCRAB           ----DILHQHLPAVLPLLLPYLRSKETGEVEVQTRVITVKMA-----YANQRR--KVDQK  819
SCORPION          ----ELLKEHYCKLLPSLNDYFLASDNISLQPLKNIHTFT-------KQSLVVKKKLPLK  830
SPONGE            SDKMDTLQCLVNEILPLLADYLKATSVQLKEEEDGGRGKQ-------YATKRYA---RMK  843
CAPITELLA         ----DVMKPFYEQLLPYLDAYLTSSADEKNDTL--------SLVQKDPMKKQGKKKIPVK  833
DANIO             ----AILQPHYTDILPHLDGYLKTTSSSEKDDS---NMEVTF--VSTGSSKGYG-QVLLR  846
MILII             ----HIIQPHYKDILPHLDGYLKTAAF-NEAQN---NWEGMN--INNPSRKGGS-KVLFH  838
BAMBOO            ----HVIEPYYKDILPHLDGYLKTAAS-NEFES---NWEMMS--MNT-SSKGGN-KVLIR  840
XENOPUS           ----DILKPYYKDIIPLLDGYLTNLSSTNESLS---TLDMVR--ISRSLHKGFN-KQLIQ  853
STERLET           ----YVMQPHYKDILPYLDGFLKTTASNDEEQN---NWEVMS--LSRSTEKGYG-RVLMR  850
GAR               ----PLIQPLYRDVLPCLDGYLKTAASNGSDQN---TWEVMC--LSSGAEKGYG-RVLLR  839
LATIMERIA         ----WVLQPYYKEILPCLDGYLKTSISAGDTPS---SWEVLR--LSRASQKGDH-KVLIR  840
CAECIL            ----YVIQPHYSEILPYLDGYLKTASSADEYQN---SWEVMR--LSRAAQKGFN-RFLVQ  841
SNAKE             ----NIIQPYYKDIVPCLDSYLKTSASTDESQN---NLEVKK--LSKAIQKGMN-KVVIQ  840
CANARY            ----HMMQPYYKDVLPLLDGYLKSSTSTVESQN---NWEVRK--LSQAAQKGRN-KVVIQ  831
OSTRICH           ----HIMQPYYKDVLPLLDGYLKNSASTVEPQD---NWEVRK--ISRAAQKGFN-KVVIQ  802
GECKO             ----YTMQPYYKDILPCLDGYLKTSTSTDDSQN---NWEVKK--LSQAVQKGSN-KVVIQ  840
TURTLE            ----HIMQPYYKDVLPLFDGYLKTTGSADESQN---NWEVRK--LSRAAQKGFN-KVVIQ  840
ALLIGATOR         ----NIMQPYYKDVLPLLDGYLKTATSPDEFQN---NWEVKK--LSQAVQKGFN-KVVIQ  800
PLATYPUS          ----HVIQPYYKDILPCLDSYLKTTALSDETKN---NMEVTM--LSRATQKGFN-KVVVR  834
TASDEVIL          ----HTIQPYYKDILPCLDSYLKTTALSDDNKD---NEEVTV--LSRAAQKGFN-KVVIK  837
HUMAN             ----HVMQPYYKDILPCLDGYLKTSALSDETKN---NWEVSA--LSRAAQKGFN-KVVLK  832
MOUSE             ----SILQPYYKDILPCLDGYLNTSTLSDETKS---HWGLSA--LSRAAQKGFN-RHVVK  831
CRASSO2           ----SVIRPFYPQILPCLDSYLKTMDQGAD----DVSENTMEM-NKSKSGKGRK-KLPVR  834
POMACEA           ----EVLAPHYANILPCLDSYLKTVDTGAE----DVSVETLVTVSSSKSKYRGK-KLPVR  831
TRICHOPLAX        ----NIIGPYFSDILPCFDDYLKSSADDTTETLVEDSSKALK------ARTGKAKKLP--  819
NEMATOSTELLA      ----DVLRRHLRNILPYLDGYLKSATDAVEEEQDQVSRRTATL-RSTYSRLGKILSLYYI  835
PRIAPULA          ----DVMQPYYKQILPHLDGYLKTTEGAD-----SVPTPTVAI-TSANATRGRK-KIPVK  850
SOFTCORAL         ----EILHPYLREVLPQLDGYLKTASELETSNEKETKL---------RSRKSGK----TK  831
PISTILLATA        ----DKLKPFLREILQCLDGYLTTLGDIQLHNE---CNTIVLI-TSSHHTSRGR-KLPLK  850
HEMICHOR          ----NALQPYYKDILPCLDGYLKTVSDTNAENA---SSQTVSL-TMTRTGKRRN-KIPIR  850
BELCHER           ----SALEPHFPHILPYLDSYLQTAADTGSSSSSD-GFQTVSL-TAASSTRGKR-KIPVK  854
STRONG            ----DVLKPYYAQVLPQLDGYLGAGSGSEDEGS---RPEVLVI-QTASSRVGRR-RIPSK  859
STARFISH          ----DSLQPHLKVILPLLDGYLRGTITQGSDAADVVQTVTMAS-ASSSGRAGKR-KLPAK  855
                        :      ::  :  ::
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                RYG70451.1
ARCHAEON            LHSSNI-V----NSLQKQQVTTEQILLFLGKLGHHNQAMLQ---SPSEVIQDSLMWSAET  964
MUDCRAB             KI-----LASKQVDATAMKRVQSLILQLIGGLDPSLGQYVIP-QDADSLAAAAVCWDSQ-  872
SCORPION            ISQYKK-IKQTDLHESELIKVQHRILRFLGSVGNQYNFAMIS-ADKIKIHEVAVAWDINK  888
SPONGE              MVEKWS-EGLHQGSRDDITSVRRRILLLLGSLGGVVNESLSKVP----SQHSLVSWDSD-  897
CAPITELLA           LLKQTM-FDAEKGKESELKEIQRKCVLLLGSLGGSINHALVFGQTA--NPPDLVAWDSD-  889
DANIO               LLKKSK-R-FSLGDESPIAAVRRRVVRLLGHLGGQLNRSLVTAVSAEDMMKRFVAWDCE-  903
MILII               HTKKSK-E-FLVSEDSAITAVRRRIVRLLGSLGGQNNRSLVTAVSAEEMMKRCIAWVTE-  895
BAMBOO              RLKNAR-D-LSMSEETPAAAVKKRVVRLLGSLGGQINRSLVAATSSEEMMKKCVAWVAE-  897
XENOPUS             QLKRMK-T-LSVKEESSLTAVRNRVVRILGSLGGQINRSLVTAASTEEMIKRHVSWDTE-  910
STERLET             LLKKAK-R-FSLTEDSPTALVRRRVVRLLGHLGGQINRSLVTATSAEEMMKKFVAWDSE-  907
GAR                 LLKRTK-H-LSMAEDSPSAVVRRRVVRLLGHLGGQLNRSLVTAASAEEMMKKFVAWDSE-  896
LATIMERIA           LLKKAK-A-VSLNEDSSLGAVRGRVVRVLGSLGGQVNRSLVTAASSEEMMKKFVSWDTE-  897
CAECIL              RLKKTK-T-LSLDQDVSLASIRNRVVQILGSLGGQINQSLVTASCAEEMMKKYVSWDTE-  898
SNAKE               HLKKSK-N-LELEADPSLEAVRARVVRLLGTLGGQINRHLITGTSAEEKMKKFVSWDIE-  897
CANARY              RIRRAK-T-LSVDNSPSLQAVRTRVARLLGSLGGQINHNLITATSAEEMMKKCVSWDTE-  888
OSTRICH             HLRRAK-T-SL-VGDPSLEAVRTRVARLLGSLGGQINHNLITATSAEEMMKKCVSWDTE-  858
GECKO               RLKKAK-S-LALEEDHSLEAIRMRVACLLGSLGGQINRNLVTAASAEERMKKFVSWDTE-  897
TURTLE              RLKKAK-T-LSLEDNLSLEAVRTRVVRLLGSLGGQINRNLLTAASTEEMMKKFVSWDTE-  897
ALLIGATOR           RLRKAK-A-LSLNEDLSLEAMRSRVVQLLGSLGGQVNRSLVTAASEEEMMKKFVSWDSE-  857
PLATYPUS            HLKKAK-A-TAPVEDLSLESVRTRVVRLLGSLGGQINRNIVTAASADEMMKKCVAWDTE-  891
TASDEVIL            HLKKSK-T-ILSDAEMSLEAVRAQVIRVLGSLGGQINRNLVTAASSDEIMKKCLAWDSE-  894
HUMAN               HLKKTK-N-LSSNEAISLEEIRIRVVQMLGSLGGQINKNLLTVTSSDEMMKSYVAWDRE-  889
MOUSE               HLKRTR-N-SSPDEALSLEEIRIKVVQILGSLGGQINKSLVTATS-GERMKKYVAWDAE-  887
CRASSO2             ILKGPK-TDSKQVFETQLAKVKQRVMTYLGRLGGEVNHALLS-G--SDVCEEAIAWDAE-  889
POMACEA             LVKERKPVDLDKGYESQLSVVKQKIVTYLGSLGGSMNFALLA-RREEEISRRAIAWDTE-  889
TRICHOPLAX          --VKVV-NPTGGSKDSPLAQVRLRIVQLLGRLGGNTNSLVIR-KGNDDGSSQAVAWDNH-  874
NEMATOSTELLA        DFVSKR-NILPQVGESSLVTIRVQILRLLGQLGGHTNLCLLG-SDGGVDSGSAVAWDTV-  892
PRIAPULA            LLQGSG-R--KMAEDSALTTARMRIVRFLGGLGGANNISLIS-CDAEDIAKVAVAWDAE-  905
SOFTCORAL           ASKSSK-RNPNEEENSPLNKVRHRILILLGTLGGKCNLGLLE-GGEGSVASSGIAWDTK-  888
PISTILLATA          LLKMKP-QSQHQMTLTPLAKVRHKILRMFGGLGGETNILLLDNTGI--NSSNAVVWDTE-  906
HEMICHOR            LLKPAT-Q--DGSDESPLTIVKLKIVHLLGLLGGSTNGYLLE-SSKEEIAKKAVAWDTE-  905
BELCHER             LLKAAA-E-RNQVQESDLVKARLRIVRFLGSLGGHTNACLVTGLTAEDLAKRAVAWDTQ-  911
STRONG              LLKKAK-D-NDQSQDSPLRSVQLQILRLLGSLGGSVNVGLLE-TSAQELSNVALAWDSQ-  915
STARFISH            LIKGAS-T-TGQTQDSPLRSVQLRILHLLGSLGGQTNAYLLE-TSAEEIAKVAVAWDTQ-  911
                                                :* :.      :             : *
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                RYG70451.1
ARCHAEON          KLSLQLSVSNQQGKLEIFIDKLLPTITEICRVKIDMTQTPNVNLIKALSSAAEALYNVVI  1024
MUDCRAB           -KHIRFAMPFGQAKIDIYLDDLLPRVVDLALNSSDRQ---------TKVAASELLHSIII  922
SCORPION          QNHLKFYLPFIDVKLEIFLDKFLPRIVTLSTTASQRQ---------TKVAACELLHAVVT  939
SPONGE            -RRLGFAVPFSDLKPEIYLDPYLPTVCELALSSSDRQ---------TKVAACEFLHAAML  947
CAPITELLA         -QHLKFDLPFLDIKTSIYFDAFLPKVVTLATVSSDRQ---------TKVAACELLHSLVL  939
DANIO             -KRLSFAVPFKDMKPVIYLDSFLPRVTELALSSSDRQ---------TKVAACELLHSLVI  953
MILII             -KPLSFAVPFMDMKPIIYLDSFIPRISELALSASDRQ---------TKVAACELLHSVVA  945
BAMBOO            -RPLSFAVPFADMKPVIYLDSFLPRITELALSASDRQ---------TKVAACELLHSVVA  947
XENOPUS           -KRLRFDVPFKDLKPVIYLDMFLPHITELALSTSDRQ---------TKVAACELLHSIVA  960
STERLET           -KRLNFAVPFADMKPVIYLDTFLPRITELALSTNDRQ---------TKVAACELLHSVVV  957
GAR               -KRLTFAVPFADMKPVIYLDAFLPRITELALSTSDRQ---------TKVAACELLHSVVV  946
LATIMERIA         -KRLSFAVPFADMKPVIYLDSFLPRIAELALSSSDRQ---------TKVAACELLHSVVV  947
CAECIL            -KRLSFAVPFVDMKPIIYLDSFLPRVTELALSTSDRQ---------TKVAACELLHSMVV  948
SNAKE             -KHLNFAVPFVDMKPIIYLDLFLPRVTELALCASDRQ---------TKVAACELLHSIVM  947
CANARY            -KHLSFAVPFADMKPVIYLDLFLPHVTELALSASDRQ---------TKVAACELLHGIVT  938
OSTRICH           -KRLSFAVPFADMKPVIYLDLFLPRVTELALSASDRQ---------AKVAACELLHSIVA  908
GECKO             -KHLSFAVPFADMKPVIYLDVFLPRVTELALSASDRQ---------TKVAACELLHSMVM  947
TURTLE            -KHLSFAVPFADMKPVIYLDLFLPRVTELALSASDRQ---------TKVAACELLHSIVM  947
ALLIGATOR         -KHLNFAVPFVDMKPVIYLDIFLPRVTELALSASDRQ---------TKVAACELLHGLVM  907
PLATYPUS          -KRLSFAVPFAEMKPVIYLDVFLPRITELALSASDRQ---------TKVAACEVLHSIVM  941
TASDEVIL          -KKLSFAVPFAEMKPVIYLDVFLPRVTELALSSSDRQ---------TKIAACELLHSMVM  944
HUMAN             -KRLSFAVPFREMKPVIFLDVFLPRVTELALTASDRQ---------TKVAACELLHSMVM  939
MOUSE             -RRLSFAVPFREMKPVIYLDVFLPRVTELALSASDRQ---------TKVAACELLHSMVM  937
CRASSO2           -QHLRFDVPFMDMKPQIYFDPFLPRIVELATKSGDRQ---------TKVAACELLHSLIL  939
POMACEA           -QHLRFDIPFFDMKPSIYFDPFLPHVVELATQSSNRQ---------TKVSACELLHSLIL  939
TRICHOPLAX        -KRLPFAIPFQDMKPIIHLDPFLPRVVELATSSSDRQ---------TKIAACELLHALVL  924
NEMATOSTELLA      -KHLPFAVPFQDMKPTIYLDPFLPRVVELATTSSNRQ---------TKVAACELLHTLVL  942
PRIAPULA          -KNLKFGVPFADMKPVIYFDVFLPRVTDLALSSSDRQ---------TKVVACELLHALLL  955
SOFTCORAL         -QHLSFAVPFQDMKPTIFLDPFLPRVVELATSSSDRQ---------TKVAASEVFHSLVL  938
PISTILLATA        -NHLTFAVPFQDMKPSIYLDPFLPRVVELAAKSSDRQ---------TKVAACECLHSLVH  956
HEMICHOR          -NHLQFPVPFMDIKPVICFDPFLPRVVELATTSSDRQ---------TKVAACELLHSLVL  955
BELCHER           -THLQFAVPFMDMKPTVCLDPFLPRICELATTSSDRQ---------TKVAACELLHSLVL  961
STRONG            -PRLNFPVPFVDMKPEIQLDAFLPRIVELALTSSDRQ---------TKVAACEALHTLVL  965
STARFISH          -PRLQFAVPFVDMKPNIDLDRYLPRVVELALTSGDRQ---------TKVAACESLHTLVL  961
                     : : :   : *  : :*  :* :  :.    :           :   *.* ::  :
```

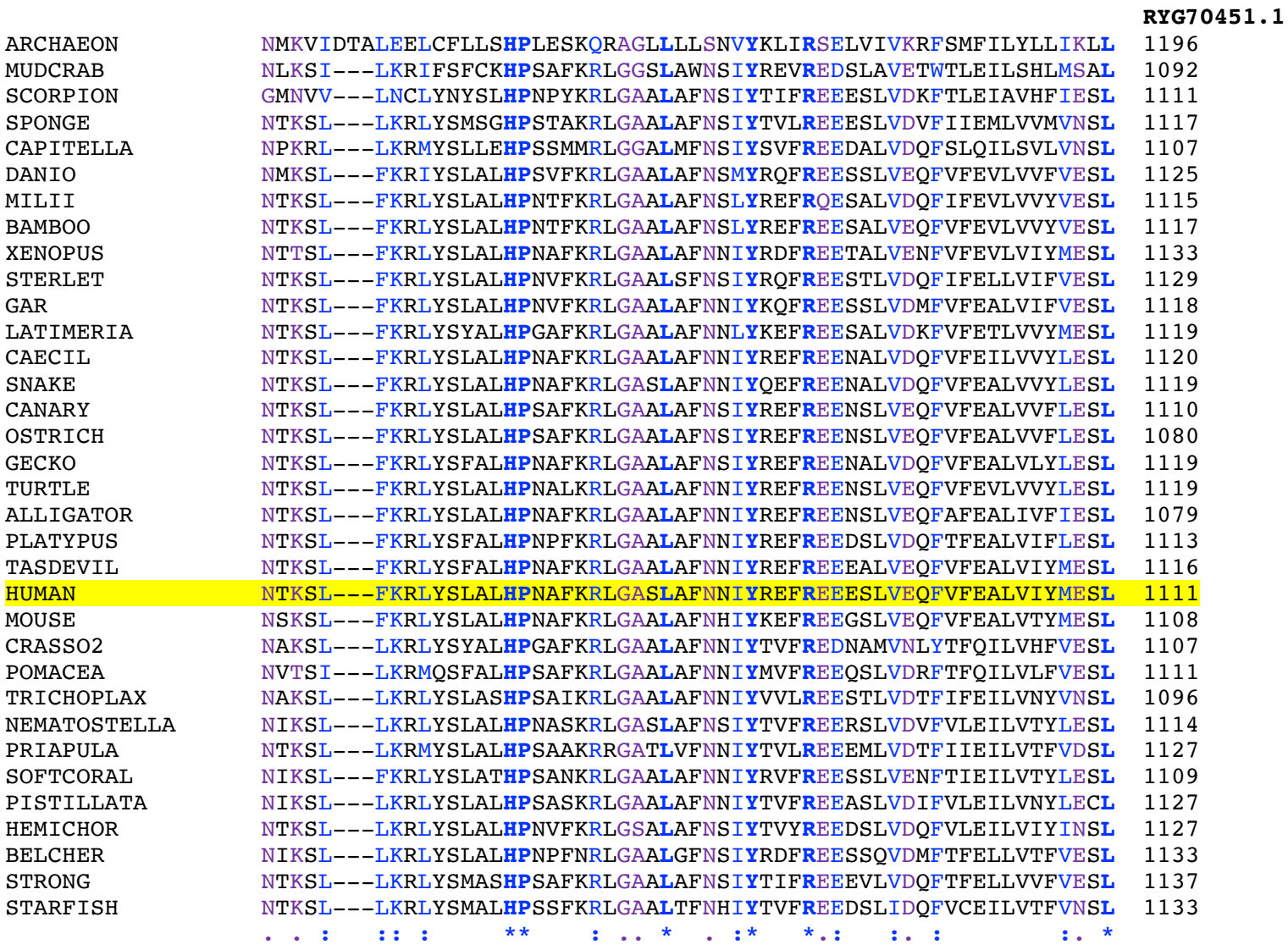
Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                RYG70451.1
ARCHAEON          FMIASSASLGV-------NYSDFYKRILPVVLQLASQSRINAFVVLFESLLDQLVSYFTS  1077
MUDCRAB           LMIGTGSQQQEGI-QAKYPMAALYHHIFQAMLQLACDPDQ-VTRQLFFTLTHQTIHWFTN  980
SCORPION          FMVGCGAQQQPEL-QAIYSMKKLYKNVLPALLQLACDVDE-VARKLFEPFTFQLIHWFTT  997
SPONGE            FVIGKGTQQSVQK---KNPMTKLYQKLIPVALQLACDVDR-VAEQLFRPLVFQMIHWFTR  1003
CAPITELLA         LMLGRSASQPTGN-----PMAAIYRKLFPQMLKLATDVEQ-VSRQLFEPLMLQIIHWFTK  993
DANIO             YMVGKGAQMTEDD-KSAPPMYNLHRKVFPVLLRLACDVDQ-VTRQLFEPLVMQLIHWFTN  1011
MILII             YTLGKGSQISEGQ---QETLYKLNRQLFPVLLRLGCDVDT-VTRQLFEPLVLQLIHWFTS  1001
BAMBOO            YMLGKGSQIAEGQ---QETMYKLNRHLYPVLLRLGCDVDK-VTNQLFEPLVMQLIHWFTN  1003
XENOPUS           FMLGKATQMPDDKKTGSSPMYKIYKRTFPVLLRLACDVDK-VTEQLYKPLVMSLIHWFTN  1019
STERLET           FMLGKGSQIPEGE-KSTPPMYRLYKRIFPVLLRLACDVDQ-VTRQLYEPLVMQLIHWFTN  1015
GAR               CMLGKGSQIPEGE-KSSPPMYKLHKRIFPVLLQLACDVDQ-VTRQLYEPLVMQLIHWFTN  1004
LATIMERIA         YMLGKGSQIPERC-GGVPPMYRLYKRIFPVLLRLACDVDQ-VTRQLYEPLVMQLIHWFTN  1005
CAECIL            YMLGKASQMPEKD-QSLPPMYQLYKRTFPVLLRLACDVDQ-VTRQLYEPLVMGLIHWFTN  1006
SNAKE             FMLGKAAQIPEGH-KNSPPLFHLYKRMFPVLLRLACDVDQ-VTRQLYGTLVMELIHWFTN  1005
CANARY            YMLGKASQMPEGC-QGPPPMYHLHKRVFPVLLRLACDIDQ-VARQLYEPLVMQLIHWFTN  996
OSTRICH           YMLGKASQMPEGC-QGPPPMYQLYKRIFPVLLRLACDVDQ-VTRQLYEPLVMQLIHWFTN  966
GECKO             YVLGKAAQIPEGQ-EVSQPMSHLYKRTFPILLRLACDVDQ-VTRQLYEPLVMQLIHWFTT  1005
TURTLE            YMLGTASQMPDGP-PGSPPMYQLYKRMFPVLLRLACDVDQ-VTRQLYKLLVMELIHWFTN  1005
ALLIGATOR         FMLGKASQMPEGR-QGSSPMYQLYKRTFPVLLCLACDVDQ-VTRQLYEPLVMQLIHWFTN  965
PLATYPUS          FMLGKASQIPEGN-QGSPPMYQLYKRTFPVLLRLACDVDQ-VTRQLYEPLVMQLIHWFTN  999
TASDEVIL          FMLGKASQIPEGK-LGPPPMYQLYKKTFPVLFRLACDVDQ-VTRQLYEPLVMQLIHWFTN  1002
HUMAN             FMLGKATQMPEGG-QGAPPMYQLYKRTFPVLLRLACDVDQ-VTRQLYEPLVMQLIHWFTN  997
MOUSE             FMLGRATQMPEG--QGLPPMYQLYKHTFPVLLQLACDVDQ-VTRQLYEPLVMQLIHWLTN  994
CRASSO2           LCVGRSATQPAR---ERYSMAPLYKKMFPSILQLACDVDL-VTKQLFEPLLMQLIHWFTK  995
POMACEA           YTLGRSAQQPGEI-QKRNPMDSLYRKLFPALLSLSCDVEQ-VCRQLFEPLVKQLIHWFTG  997
TRICHOPLAX        YMIGRGAQQPGGT-GSVTNYGNLYKKIFPAILTLASDVEQ-VSQQLFQPLVYQLIHWFTG  982
NEMATOSTELLA      YMLGKGVTQPDVK-KVALPMQNLWKKLIPVLLQLACDVER-VSAQLFHPLVMQLIHWFTN  1000
PRIAPULA          YILGTGAQQPDSI-KSKRPMSALYSRLFPVLLRLGCDVEP-VAKQLFEPLVMQTIHWFTL  1013
SOFTCORAL         FMLGKSVQIPDA--SSKSPLEKLWKRVFPVVLQLACDVEQ-VSQQLFRPLLFQLIHWFTN  995
PISTILLATA        YMLGKSVTQPQG--FKKSPMEHLWKHVFPTLLQLACDVEQ-VSEQLFKPLVFQLIHWFTN  1013
HEMICHOR          YMVGRGAQQPDST-QVKAPMEKLYKKVLPALLQLSCDVEQ-VARQLFEPLLSQLIHWFTC  1013
BELCHER           YMVGQGAQQPGEM-QAKNPMTRLYKKVFPVLMQLACDVEQ-VARQLFDPLMMQLIHWLTN  1019
STRONG            FMLGKGSQQPDQR-EAKSPMNQLYKKVFPAVLQLACDVEQ-VARQLFEPLVMQLIHWFSG  1023
STARFISH          FMLGKGTQQPEQR-QAKSPMQHLYRRVFPALFRLSCDVEQ-VARQLFEPLVMQLIHWFTG  1019
                    :. .                 :  .     : *. :    .   *:  :    : :::
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                RYG70451.1
ARCHAEON            PHHRNSKNEEYGRVLLETLLENIVATNDNNMKELCGTTFTKYLQCCIHSHIRNRT-EGSV  1136
MUDCRAB             NKKNENPD---TAVLLESIMDGIVTANNPALRDVSAQCLAEFVIWSRKQSREKNQ--ASL  1035
SCORPION            KRMINSDE---TKQFVQVIWDGLVQSKDAVFRDFSARCLKEFVQWSIKQTSVREQEENPI  1054
SPONGE              NTQYESPD---TVTLLEAILEGIEHPTNASLRDFSAQCIKEFLVWSIKQTSKKQQERSPM  1060
CAPITELLA           SNNSHRPD---TEALLNSLMDGIVSPSDSAVRDFSAKCIREFLAWSIKQTSPKEMEAGPA  1050
DANIO               NRKFESQD---TVAVLEAILDGIVDPLDSTLRDFSGTCIQEFVKWSIKQTTPKQQEKSPA  1068
MILII               NRKFESRD---TVAMLEAILDGIVDPVDSTLRDFCGQCVREFLKWSIKQTTPEQQAKSPA  1058
BAMBOO              NRKFESRD---TVALLEAILDGIVDPVDSTLRDFCGNCVREFLKWSIKQTTPEQQQKSPV  1060
XENOPUS             NKKFESQD---TVALLEAILTGIVDPVDSTLRDFCGQCIQEFLRWSIKQTTPDQQAKSPV  1076
STERLET             NTKFESQD---TVAMLEAILDGVVDPVDSTLRDFCGQCVQEFLMWSIKQTTPKQQEKSPA  1072
GAR                 NRKFESQD---TVAILEAILDGIVDPVDSTLRDFCGQCIQEFLKWSIKQTTPKQQEKSPA  1061
LATIMERIA           NKKFESQD---TVAMLEAIMDGIVDPIDSTLRDFCGLCIQEFLKWSIKQTTPKQQESTPA  1062
CAECIL              NKKFESQD---TVALLEAILDGIVDPVDSTLRDFCGHCIREFLKWSIKQKTPQQMEKSPV  1063
SNAKE               NKKFESQD---TVTLLEAILDGIVDPVDSTLRDFCGQCVHEFLKWSIKQTTPQQQEKSPV  1062
CANARY              NKKFESQD---TVAFLEAMLSGIVDPVDSTLRDFCGQCIREFLKWSIKQTTPRQQEESPA  1053
OSTRICH             NKKFESQD---TVAFLEAILGGITDPVDSTLRDFCGQCVREFLKWSIKQTTPKQQEKSPV  1023
GECKO               NKKFESQD---TVTLLEAILDGIVDPVDSPLRDFCGRCVREFLKWSIKQTTPQQQERSPV  1062
TURTLE              NKKFESQD---TVALLEAILDGIVDPVDSSLRDFCGQCVREFMKWSIKQTTPQQQEKSPV  1062
ALLIGATOR           NKKFESQD---TVALLEAILDGIVDPVDSTLRDFCGQCIREFMKWSIKQTTPQQQEKSPV  1022
PLATYPUS            NKKFESQD---TVALLETILDGIVDPVDSTLRDFCGQCVREFLKWSIKQTTPEQQEKSPV  1056
TASDEVIL            NKKFESQD---TMTLLETILDGIVDPVDSTLRDFCGQCVREFLKWSIKQTTPQQQEKSPV  1059
HUMAN               NKKFESQD---TVALLEAILDGIVDPVDSTLRDFCGRCIREFLKWSIKQITPQQQEKSPV  1054
MOUSE               NKKFESQD---TVALLEAILDGIVDPVDSTLRDFCGRCVQEFLKWSIKQTTPQQQEKSPV  1051
CRASSO2             NNKAESEE---SMALLDAIYDGIIQPNDTALRDFCAVCLREFLKWSIKQTK--NVEKSPI  1050
POMACEA             NKMAESPE---SMALLDSIFDGLVQQDNTMLRDFAAQCLREFLIWSIKQTSKKAMETNPR  1054
TRICHOPLAX          NSNYESVE---TIALLNALLDGVIHSTDSALRDFCAKSLREYLHWSIKQTTKKQQEKTSN  1039
NEMATOSTELLA        NRKYESPE---TIALLDALLEGVVHPTDTSLRDFSAQCIREFLQWSIKQTSAKQLEKSPI  1057
PRIAPULA            NRMFESPE---TMCLLDAIMEGIVDATDAALRDFCGSCIREFLIWSIRQTTVRQQERSPG  1070
SOFTCORAL           NKQYESPD---TIILLETLLDGIVHPTDTALRDLSALALEEFLRWSIKQATKNQLEKSPI  1052
PISTILLATA          NRKYETPE---TMALLDAIVDGIVHPVDTSLRDFSAQCIKEFLQWSIKQSSEKQLEKSPI  1070
HEMICHOR            NKKFESPE---TIAMLDAILDGICHPTDTALRDFSAKCVKEFLYWSIKQTSKKTMEKSPI  1070
BELCHER             NRKFESEE---TITLLDAIMDGLVHPTDTALRDFSSRCVREFLQWSIKQTTPKQLEKSPI  1076
STRONG              NKKYESDE---TSTLLNAILAGIVHPTDTALRDFCARCISEFLRWSIKQTSKKQQEKSPI  1080
STARFISH            NKKFESEE---TTALLNAMLDGVIHPTDTSLRDFSACCLKEFLKWSIKQTSKKQQEKSPI  1076
                        .  :      .:: :  .:    :  .::...  . :::  . :.
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"



Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                  RYG70451.1
ARCHAEON            DVKDLSEE---NEKVCY-PLSSYVR----------------TRIRR--------------  1222
MUDCRAB             DLAHNDDLVLGTHEQTRAAILHVRRILIVRKELFWK-MSSNRRIPIDFEGG----TFEDM  1147
SCORPION            AIAHYDDKILGTQDKCKQALNHLERIMEVKAKLLSK-TSKKRRPLRNINDS----ILPEV  1166
SPONGE              KLAHKDAQSIGTVDQCSLSLDHMSRIIKAKSSTCLSKANKNRRVPRGLKSA----DLSIL  1173
CAPITELLA           ALAHRDDKSLGTQEQCKSALLHVERILIKKQVTFNK-DSKQRIKPRGWRDA----NMTTA  1162
DANIO               ALAHFDEKSVGTVQQCCSSLDHLKRIIKHKADSLN--INSKRRIPRGFPADQ-SVCLSNV  1182
MILII               ALAHADDNSLGTVQQCCDAIDHLNRIIKQKASALN--KPIKGRVPRGFPPDQ-PVSLKEV  1172
BAMBOO              ALAHADDKSLGTIQQCCDCINHLKRIIKQKAHELN--KPVKRRVPRGFPADQ-MVCLTDV  1174
XENOPUS             ALSHADEKSLGTTQQCSDAVDHLKRIIIRKAASLN--KATKRRIPRGFPQGN-TVCLFDI  1190
STERLET             ALAHTDEKSLGTLQQCSDAIDHLKRIIKQKAASLNAEKTSRRRVPRGFPPDK-PVCLLDV  1188
GAR                 ALAHSDEKSLGTLQQCSGAIDHLKRIIKHKAATLN--KSSRRRVPRGFPPDK-PVSLTDV  1175
LATIMERIA           ALAHMDEKSLGTVQQCCDAIDHLKRIIEQKAPSLN--KAATRRVPRGFSPDK-VFCLSDV  1176
CAECIL              ALSHQDEKSLGTVQQCCDAIDHLKRIIIHKAPSLN--KTLKRRLPRGFPSTKSSFCLSDL  1178
SNAKE               ALTHGDEKSLGTIQQCCDAIDHLKRIIKHKASTLN--QKSTRRLPRGFPS-R-SICLEDV  1175
CANARY              ALAHTDEKSLGTAQQCCDAINHLKRIIKHKAPSLN--KEGKRRVPRGFPPTK-SVCLEDI  1167
OSTRICH             ALTHADEKSLGTTQQCCDTINHLKRIIKHKAPSLN--RAGERRVPRGFPATK-TVCLLDI  1137
GECKO               ALTHGDEKSLGTTQQCCDAVDHLKRIIKHKASTLN--KESQRRLPRGFPPAK-SICLEDI  1176
TURTLE              ALTHTDEKSLGTVQQCCDAIDHLKRIIKHKASSLN--KAEKRRIPRGFPNAK-SVCLLDL  1176
ALLIGATOR           ALTHTDEKSLGTTQQCCDAIDHLKRIIKHKAPSLN--KAEKRRLPRGFQPAE-SLCLLDI  1136
PLATYPUS            ALTHADEKSLGTIQQCCDAIDHLKRIIEKKHISFN--EEKNRRLPRGFPNAR-SVRLLDL  1170
TASDEVIL            ALTHADEKSLGTIQQCCDAIDHLTRIIEKKHITLN--KPKKRRLPRGFPPVQ-TLCLLDL  1173
HUMAN               ALAHADEKSLGTIQQCCDAIDHLCRIIEKKHVSLN--KAKKRRLPRGFPPSA-SLCLLDL  1168
MOUSE               ALAHEDEKSLGTVQQCCDAIDHLRRIIEKKHVSLN--KAKKRRLPQGFPPLT-SLCLLDL  1165
CRASSO2             AIAHEDESSMGTQTQCKMVLDHMERIIKVKANVLSK-EDKNRTEPKQWSVV----KLDIA  1162
POMACEA             GIAHQDEASLGTQEQCKKALEHVEKIVCKRVDILRK-PSPHRKEPSEWSKQ----TLDIA  1166
TRICHOPLAX          ALSHTDEKSLGTQEQLSKALAHIERIIKAKASTLNK-ESKNRRTPTGFM-TK-TVTLHHV  1153
NEMATOSTELLA        ALAHTDDPAQGTQDQCSQVISHLERIIKTKATLLDK-ENKQRRIPRGFQMLD-SITLSHL  1172
PRIAPULA            ALAHNDEKSLGTQEQCAQALDHIERILRGKAHLLNK-DKKSRRRPKEFTDA----TLFTT  1182
SOFTCORAL           EMAHEDEISLGTQSQCIEVISHLERIIVSKSSVLLN-VNKKRRVPRGFSAD--TTTLRHL  1166
PISTILLATA          CLSHGDEEARGTQEQCVQVIIHLERIIHSRAQLLVK-ENHRRRIPRGFASQS-SITLIHM  1185
HEMICHOR            AMAHFDDKSLGTQEQCVRVVDHLERIIRVKANMLNR-TSKTRRVPRDFNRDD-CPTLSHV  1185
BELCHER             ALAHHDEKSLGTQAQCVAVLTHLDRIITTKADLLNK-HSKVRRVPRGFDRES-PPTLPDL  1191
STRONG              ALAHHDDKSLGTQEQGSEVLKHLERIMRVKAALLNK-ESKNRRVPRGLPEDC-SPTLSHM  1195
STARFISH            ALAHHDDKSLGTQLHGVEVLNHLERIIRVKADMLNK-ESKIRRIPREFPAGV-CPTLSML  1191
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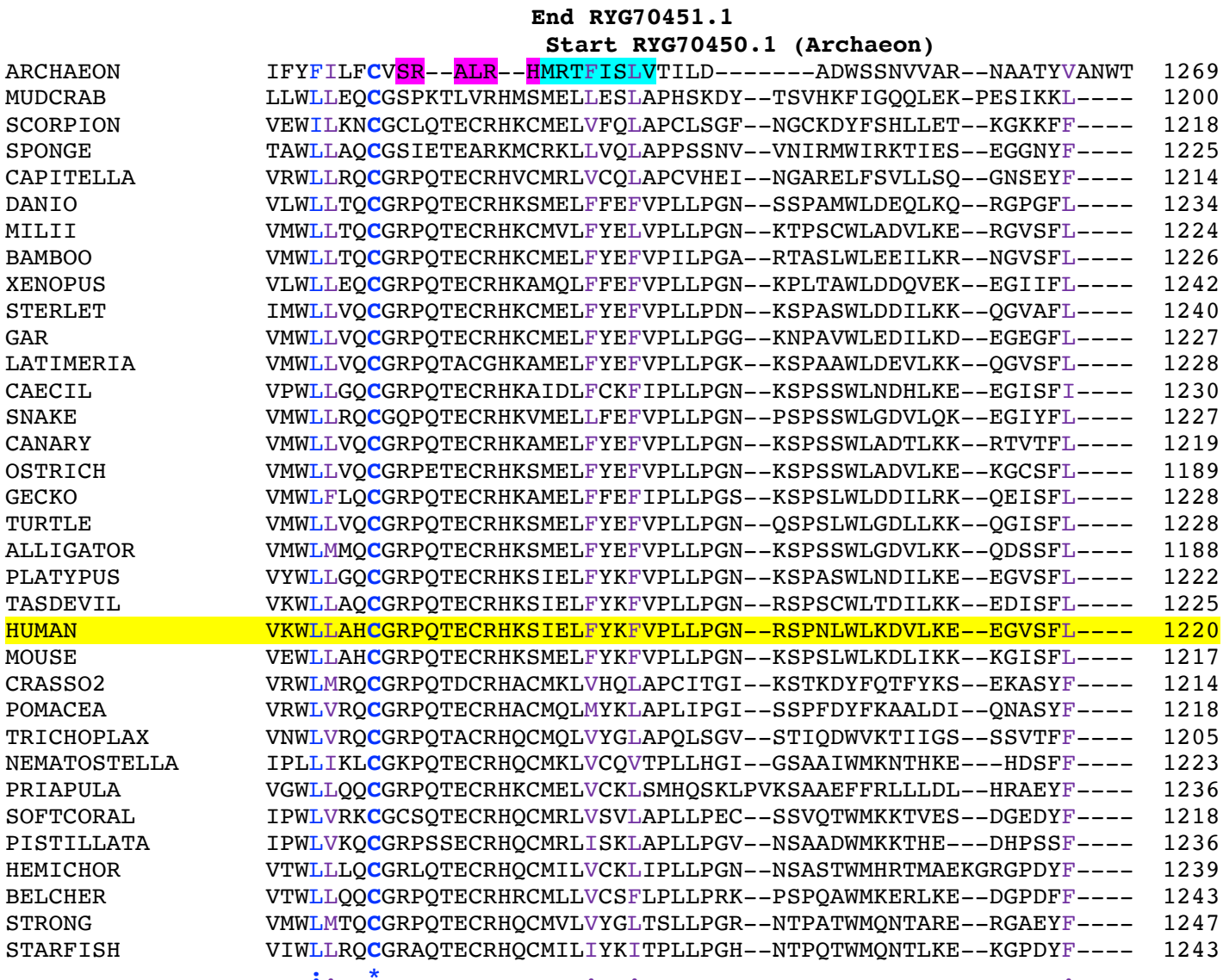
Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"



Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

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                                                                                RYG70450.1
ARCHAEON          DMLNKFSGCTRA----------VIAYVNE-HVNHRMGSNMVLLLFVAALDVYNWLVSMQ  1317
MUDCRAB           --VDIIEGGGQAG---LGIKHHTEPTSLATAGVPGN-LMNIYFEALLAGLDGYSWLIGKG  1254
SCORPION          --LNCFESEMSN----------TVPSFNQ-NDGLK-PIINWLEGLHTMLDCYYWVFGQS  1263
SPONGE            --VTRFESHGH-----SGILKAPTLAPA----PNIN-IAINWLQSLQAAVDNYRWLLKEQ  1273
CAPITELLA         --IQRFEFGMY-SSARMGLNQKPTMSRVQE-NFSLN-AACTWFDLVLATLDCYTWVFGER  1269
DANIO             --ISCLEGGG--------LLSQPTLREIEA-PFSIR-GTLQWMDLLLAALDCYNTFTNLR  1282
MILII             --IGKFESAGSDHAKCSGIIYQPTLKDLQE-PFSVR-AALQWMDMLLAALDCYNTFVRLA  1280
BAMBOO            --VNKFEGAGSDHDNCSGIICHPTLQALKE-PFSVR-AALQWMDMLLAALDCYNTFIGLH  1282
XENOPUS           --INRFEGAGHSDGMHTGIFNIPALHDLHE-PFSMH-AVLQWLDMLLAALDCYNTFIGMR  1298
STERLET           --ISRFESAGREDGGCSGILSQTTLHDLQE-PFSLR-AVLQWMDMLLAALDCYNTFIGLH  1296
GAR               --IRRFEGAGRCDGDSSGLLSQATLRDLQG-SFSVR-AALQWMDLLLAALDCYNTFIGLH  1283
LATIMERIA         --IQKFEGGGNTDDRLSGILSQPTLCDLQE-PFSLR-AVVQWMDMLLAALDCYNTFIELR  1284
CAECIL            --ISRFEGGGSDGDHQSGLIAQPTLCDLKE-PFSLR-AVVQWMDMFLAALDCYNTFIWMR  1286
SNAKE             --IKKFEGGGCEGENVSGILSHPTLYELQG-SFSLQ-AVVQWMDMLLAALDCYNTFIEPG  1283
CANARY            --INKFEGGGTDAKSPSGILSQPTLHGMQE-PFSLQ-AVMQWMDMFLAALDCYNTFFELQ  1275
OSTRICH           --INKFEGGGRDADSPSGIFSRPTLHGIQE-PFSLR-TVMQWMDMFLAALDCYNTFFELR  1245
GECKO             --IKKFEGGGDEGKSVSGILSHPTLSGLQD-NFSLR-AVVQWMDMLLAALDCYNTFIEQG  1284
TURTLE            --INKFEGGGNDGDNLSGILSQPTLCDMQE-PFSLR-AVVQWMDMFLAALDCYNTFIEQG  1284
ALLIGATOR         --INKFEGGGNQDDNLSGILSYPTLHHLQE-PFSVR-AVVQWMDMLLAALDCYNTFIEQR  1244
PLATYPUS          --ISRFEGAGTGNDHLSGILVWPTLLDLEG-PFSLR-AVLQWMDMLLASLECYNTFIEEK  1278
TASDEVIL          --INRFEGAGNASEHLSGILAQPTLFDLQG-PFTLR-AVVQWMDMLLAALECYNTFIEER  1281
HUMAN             --INTFEGGGC--GQPSGILAQPTLLYLRG-PFSLQ-ATLCWLDLLLAALECYNTFIGER  1274
MOUSE             --INTFEGGASSSDQPAGILAQPTLVYLQG-PISLR-GVLQWLDLLLAALECYNTFIEKE  1273
CRASSO2           --INRFEGKQQ----KYGLLSCPEMTAVDS-SFSVQ-NAVSWFDHYLAALDCYIWTFGES  1266
POMACEA           --VVRFEGGGQ-VGDRGGLCGHPTPSKVAE-NFSLK-AVLSWFDMLLAVLDCYCWVFGEG  1273
TRICHOPLAX        --ITRFEGGG----SKYGIGRYQTALDISD-TFNLR-SMKNWYDYFLAALDCYSWVFSEK  1257
NEMATOSTELLA      --VRRFEGGGG---RGNGILTYPTLADMGG-AFSLK-ETLLWFHYLLAALDCYTWVFGEQ  1276
PRIAPULA          --IERFEAGGIPGGATCLSNQ---QEGFEA-PISMT-TALSWFDHMLAILDCYTWVFSAK  1289
SOFTCORAL         --ILRFECGFA---GKSGIQKHPTLSSINE-TFSLT-TTKHWFDLVLAALDSYIWSFGQR  1271
PISTILLATA        --VHRFEGGGGG--GQKGIEQYPTLAHIGG-HFSLK-ETILWFEFVLAALDCYTWSFSEH  1290
HEMICHOR          --ITRFEGGGGKGGHKTGISKHPTLNTVDK-TFSVK-VASNWFDLFLAALDCYTWVFGEK  1295
BELCHER           --ITRFEGGGGKTGHKSGIKKHPKISTMDS-TFTVK-TAVSWFDLLLAALDSYCWVFGQR  1299
STRONG            --VGRFEGGGHK----SGIQKQPTLASVEQ-QFSVK-ATITWLEYLLAALDCYVWVLGES  1299
STARFISH          --VSRFEGGGVKAASRSGISKYPTLSTMGQ-PFSVK-LACSWFDHLLAALDCYTWVFGEK  1299
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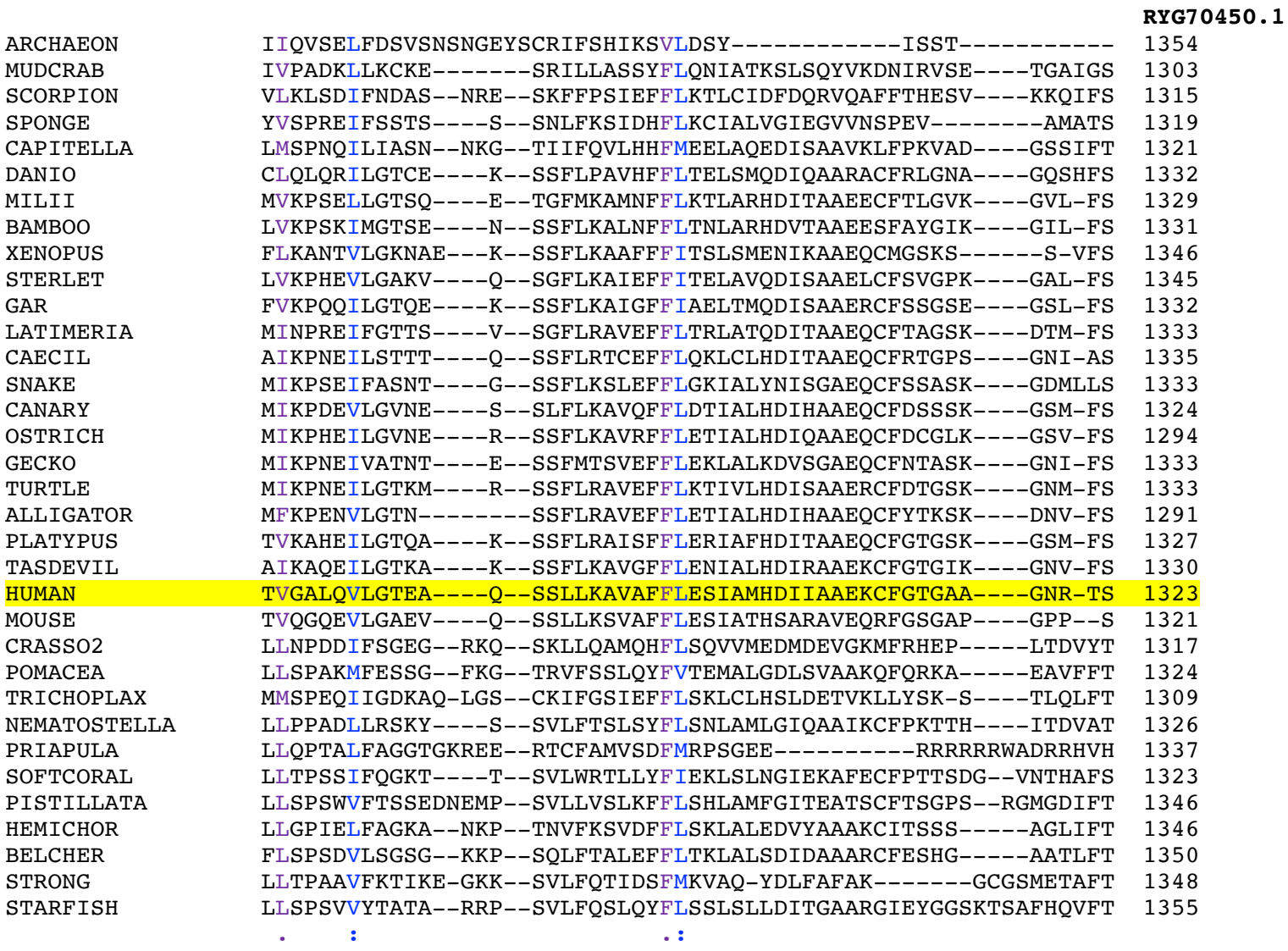
Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"



Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

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                                                                                RYG70450.1
ARCHAEON          --VTSNSDWRQEDAWIRSVVFLTTIISKSPSGRTLTELQAFGIPITSLFRNLVHFSLNYS  1412
MUDCRAB           PLEYEASNKLKCTVVVRLFDFVCVLLQDGVQS--VQLLNEYSIFTAEMYGLI-LQCVLNP  1360
SCORPION          PKEKDEYLRLNCFIIVRLINFVTTIVENYHLQ---LNTIPSTFWSINFWNCI-YSSVLNP  1371
SPONGE            IHERGEYQRNKWCTIELLLTFIELLLTKHTSETVSFEYVPDSLWSQELYTIV-MDSLFYS  1378
CAPITELLA         PREREDYNQTKCTVIVRTLSFICTMFGNYKTE--SLKVIPTSFWSSNLWDTL-LLAVLQP  1378
DANIO             PRETEQYNYSKCSIIVRMLEFSTMVLQKCPQD--LWKLMEKDVFNSSLFTLV-VLAVCEP  1389
MILII             PREREEYNYCKCTIIVRIMEFACLILEGLQQD--CWKVLEKDLLNSDLFELI-AMVVIDP  1386
BAMBOO            PREREDYNFNKCTIIVRIMEFVSMVLEDCQQD--FLKMLEKYLLNSTLFELV-ATVVIDP  1388
XENOPUS           PHEIEAYNYSKCTIIVRIMEFITMFIDICQQD--SLKILENSVFNEPMWELI-AITVCDP  1403
STERLET           PKEREDYNYSKGTIIVRMMEFVSMVLENCQPE--FWKLLEQNILNPTFFELI-TTTVCDP  1402
GAR               PREREDYNYCKGTIIVRLMEFVTMVLDKCSQD--LWKVLERDILHLTFFELI-ATTVCEP  1389
LATIMERIA         PREREDYSYSKCTIIVRILTFVSMVLEKCQPD--LWKVLEKDLLTPALLELT-VRTVCEP  1390
CAECIL            PQEREDYNYSKCTIIVRIMEFVSMILENCQQD--FWRLLEKDLLNNNLVELT-VLTVCDP  1392
SNAKE             PHEREEYNYSKCTIIVRIMVFGSMILETHQQH--VWKLLEKELLNENLIKLV-VKTICDP  1390
CANARY            PQERDKYNYSKCTIIVRILEFVTVILEMCQQD--FWKLLEKELLNASFIELV-VMTVCDP  1381
OSTRICH           PQEREVYNYSKCTIIVRSMEFVTMVLESCQQD--FWKLLEKELLNASFIELL-VMTVCDP  1351
GECKO             PQEKEDYNYSKCTIIVRIMVFVSMILETCQQD--FWKLLERELLNKNLIELT-VRTVCDP  1390
TURTLE            PQEREEYNYSKCTIIVRIMAFVSMILETCQQD--FWKLLEKELLNANLIELL-VRIVCDP  1390
ALLIGATOR         PQEREEYSYSKCTIVVRIIRFVSMILETCQQD--FWKLLEKELLNLNLIELL-VVTVCDP  1348
PLATYPUS          PQEREEYNYSKCTIIVRIMEFATMLLNTYQ-D--TWKLLEKDLLNATFMELV-VEIVCDP  1383
TASDEVIL          PQEREEYNYSKCTIVVRIMEFSSMLLNTCQ-D--VWKLLEKDLLNAYFMELL-VKTLCDP  1386
HUMAN             PQEGERYNYSKCTVVVRIMEFTTTLLNTSP-E--GWKLLKKDLCNTHLMRVL-VQTLCEP  1379
MOUSE             LHEEEKYNYSKCTVLVRIMEFTTTLLIASP-E--DCKLLEKDLCNTNLMQVL-VKMICEP  1377
CRASSO2           PKERDEYNRTKCTAVVRTLNFFCVLVARSPSS--VKKLLPSEILGKDLWNLI-SMCVLQP  1374
POMACEA           PKEKDDYNKVKCTVLIRMWNFLTVLIARYPSE--AFKVIPQTLFCDDLWRLC-IRCVVQP  1381
TRICHOPLAX        PREIEEYNMCKCTTIVRLINFLAVLLQMSPTS--IIEGIPRQIWSQNLFEMI-FLCILTP  1366
NEMATOSTELLA      PKEMDEYNRVKCTVIVRIMNFFTVLLQAYPDQ--GFKIVPTSLWSDDLFTVV-FSCALEP  1383
PRIAPULA          PGEMEKYNRSKCMVVIRAMDLFSILLNMA-----SLQVIPDSTWSMELWDVV-LLSVLDP  1391
SOFTCORAL         PSEIQEYNRAKCTVLVRIIAFITLLLQMNAKE--YLEIVPSELWTGKFFEAL-CTSVLEP  1380
PISTILLATA        PKEIDDYFRAKCTVIVRVLNFLTILLQDFPQE--TLKTLPPEFWSEDLFEVV-LSCVLEP  1403
HEMICHOR          PREIDDYNKYKCTAIVRLLDFISVLLAVHTKD--LSKSIPLSFWSTNLFEVI-VSCVLDP  1403
BELCHER           PRETEDYNYGKCTVIVRIMDFFTVLLGAFPQD--AYKVVPDAVWKSPLYDMV-VTAALEP  1407
STRONG            PREEEDYNRTKCTVIIRLFYFMGAMLGSHTKE--ALEVIPSKLWTGLFAEIL-CGCVLKP  1405
STARFISH          PRESEEYNQEKCTVIVRLWDFLTVLLENYASD--AVKVIPKSIWQDSLFDLV-VTCILQP  1412
                            :         :   ..                    :
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Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

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                                                                                                RYG70450.1
ARCHAEON          GILVGAVDAQVQHFQQIQSDDENSYSLVKRTQLLLKLALALRP-----GVVATSVIHSEV  1501
MUDCRAB           SPLAE---GVNVPLK--------SQHVIEGLQILQRS-GWLAQ-----CSVIRKSLASEL  1462
SCORPION          LNLN---DKDLKILE--------IQEMLLGYEQLIEN-KL----WPKQNCNKSKKLACDM  1473
SPONGE            VSYN-ESTTSSGILL--------FNRLVQGHIYLAESNKCLSDVLKSMGISEEESLAMRL  1489
CAPITELLA         IPLL---EPNQDYIQ--------LRLLVSGFEQLNSA-GLLSNTLVS---KSSEKLAEDL  1482
DANIO             --LY-ETDTRNSHAS--------MNLLLSACRQLHQS-GLLNSVLHSQDASYGCSLGSKL  1493
MILII             --LY-SPGARTDHAG--------LRSILSACQQLHKA-DLLNSAIDCEAGSLSSSLSLKL  1490
BAMBOO            --LY-SQ---SDHAK--------LNSILLACKQLHKA-GLLNSVLKCQIGSIVPPLNLKL  1489
XENOPUS           --LY-DPGARFNRVK--------LGSVLSACKQLYKA-EFFNSIVPEQVGGQ--RFGSKL  1505
STERLET           --LC-NVDARSDRAR--------LVFVLSACKQLHKA-GLLNSALQSQAASFGLSLGSKL  1506
GAR               --LY-GSEARSEHAR--------LALVLSACKQLHRA-GLLNSTLQSQAASFGLSLGSKL  1493
LATIMERIA         --LY-NPDARLDHIR--------LGSILSACKQLYDA-GLLNSAVQYQSGDFNLQLGSTL  1494
CAECIL            --LY-NQDARHYHAR--------IGSILSACKQLHKA-GLLNSVLQSQTAGLQFTVGSKL  1496
SNAKE             --LY-NPEARLDHVR--------YIAILSACRQLHKA-GVLHCILQSKGADLQFETGSKL  1494
CANARY            --LF-NSEARLDQVR--------FGAVLSACKQLQKS-GLLHSVLHGQDEGSHFSVGSKL  1485
OSTRICH           --LF-NSDARFDQVK--------YSAILSACKQLQKA-GLLHSVLHNQDEVPHFSLGCKL  1455
GECKO             --LY-NPDSRLDHVR--------LGAILSACKQLHRV-GLLHCTLQSQGVGLHCEAGSKL  1494
TURTLE            --LY-NPDARFDHVR--------LSSILSACRQLHKA-GLLHSTLQSQGSGLHFTVGSKL  1494
ALLIGATOR         --LY-DPDARFDRVR--------ISSILSACKQLHKA-GVLHSVLQSQGSGLHFTVGSQL  1452
PLATYPUS          --LY-KPDARFDRPR--------LASILSACKQLQRA-GLLHAAVHPQASHLQRPGSTKL  1487
TASDEVIL          --LY-NSDARFDRAN--------LASLLSACKQLHKA-GLLHSTVESQATDLPHPIGTKL  1490
HUMAN             --LY-GPDAQVDRSR--------LAAVVSACKQLHRA-GLLHNILPSQSTDLHHSVGTEL  1483
MOUSE             --LC-SSGARQERSK--------LLSILSACKQLHKA-GFSHVISPSQSTALNHSVGMRL  1481
CRASSO2           RPLDD---PSTDHVF--------LQQLVSGYQLLHSV-GLLSKVSM--ATTLPD-LANKL  1477
POMACEA           ISLTS---SSIDYTN--------LQQTVEGYCQLHDV-RILLEVLG--KHGQPEKLAELL  1485
TRICHOPLAX        IRFDRDNELNIDFER--------LTFLIKGYKQLLTM-GILKTTPADHK-----DLIEKI  1472
NEMATOSTELLA      IPLAGE-DSRVDHLY--------LSHLVTGYKQLHAA-GLLMDVMLTRGSTKPLEYGSRL  1478
PRIAPULA          RLPCLMTDTGDDTRY--------LSSLVCGYEQLYKA-ELLLPALQEAAP----ALPASL  1494
SOFTCORAL         LPLSGEECDQMDHTR--------LQLLVRGYQQLHRA-EILLPALAKEGEWSAEKCSEEL  1491
PISTILLATA        FPLSNPQEHQVDCLR--------LAYLVQGYQQLHCA-GLLLPALKAQARNASEEYAVKL  1514
HEMICHOR          SILKGD-DKGINYVK--------LTHMVSGYEQLHKA-NLLLPALQKTGMASGDKFSQQL  1513
BELCHER           EVSAGV--AELDHVR--------LTLMVSGYQQLHNA-GLLLPA---LGTNSGKSLASEL  1513
STRONG            MLFSNESDLGLDHVQ--------LQHLVNGYKQLQKA-KLLTRQT--TNQALS------I  1508
STARFISH          SMFGRDEGLTTDHGK--------LIHLVKGYEQLHQA-NLLSAAT--TGHGSGSSFAVKL  1521
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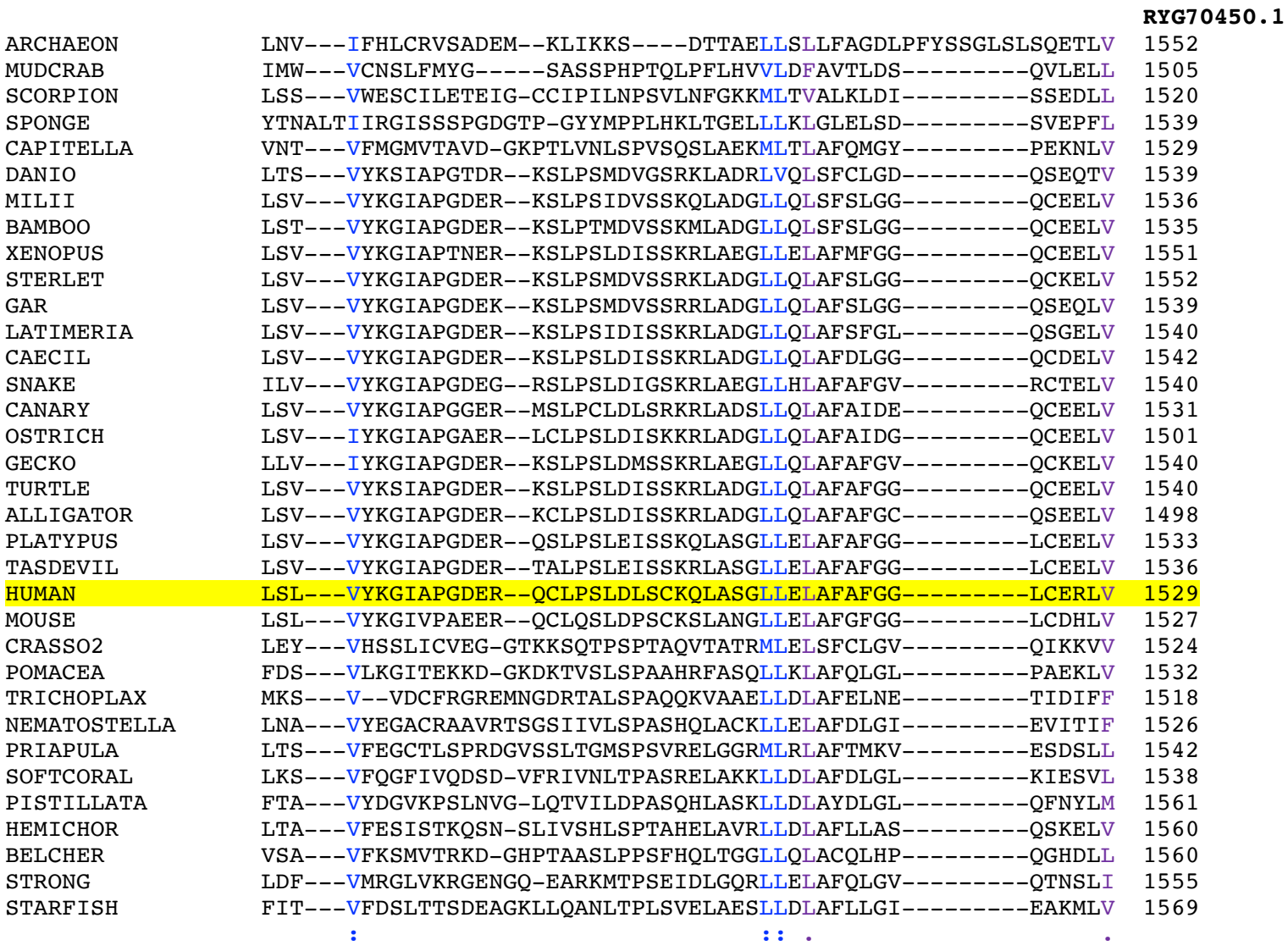
Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"



Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

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                                                                                RYG70450.1
ARCHAEON          FSDSAAAKNPSLLSV----------IAHPKYGSKLYQQYSRLIIDAVVTAPSSSPVSLYH 1602
MUDCRAB           VKQ---VTNMEDVKG--------VTGQQIEKGFHILNVLGNKIIPHILPCCD-------- 1546
SCORPION          KKL---LD-EQQLYVSNLK-------TKTRRGLIMFSTYQQEISLFAGINSK-------- 1561
SPONGE            LLV---LS-PAQSGA--------GASFAAQDGLLLYITYSGLINNKLLLHIK-------- 1579
CAPITELLA         ELI---FN-SNNIHGVSTS------VQCSPHGTLFYAAFKSVVNLNFVKSVE-------- 1571
DANIO             GLL---LN-TITLSV-PLSGSLNPHFLSFSHGEYFYSLFQTSLNTELLRSVD-------- 1586
MILII             SLL---LN-TMELSV-PLSGATQKNFITFSHGEYFYSLFSETINAELLKSLK-------- 1583
BAMBOO            SLL---LN-TVELSV-PLSGASQRHFISFSHGEYFYNLFPETINSELLRNLN-------- 1582
XENOPUS           SLL---LN-TVILSV-PLPGTSQRNIINFSHGGYFYTLFAETINTELLNNLD-------- 1598
STERLET           DLL---LN-SIMLSV-PLSDTSQKNFITFSHGEYFYSLFQETINSELLKNLD-------- 1599
GAR               SLL---LN-TIMLSV-PLSGTSDKNFISFSHGEYFYSLFQQTINIELLGSLD-------- 1586
LATIMERIA         CLL---LN-RVTLSV-PLSGTSQRNFITFFHGEYFYNLFMETTNSELLRNLS-------- 1587
CAECIL            SLL---LN-TVKLSV-PLSGTSQRNIISFSHGEYFYSLFSETINTELLKNLN-------- 1589
SNAKE             SLL---LN-TLMLFV-PLSGAAQESLINFSHGEYFYSLFLEIINRELLKNLE-------- 1587
CANARY            SLL---LN-TVVLSV-PLSEASQNQLMNFSHGQYFYSLFSETINQQLLKNLD-------- 1578
OSTRICH           SLL---LN-TVVLTV-PLLGASRKNLVNFSHGEYFYSLFSETINEQLLKNLD-------- 1548
GECKO             SLL---LN-SLMLSV-PLSGVSQRNLISFSHGEYFYSLFSDTINRELLKNLD-------- 1587
TURTLE            SLL---LN-TMMLSV-PLSGTSQRSLISFSHGEYFYSLFSETINQELLKDLD-------- 1587
ALLIGATOR         SLM---LN-TAMLSV-PLSEAAPRNLLSFCHGEYFYNLFSETINHELLKNLD-------- 1545
PLATYPUS          SLL---LN-TVVLSV-PLAGTSQRNLISFSHGEYFYNLFSATINTELLKNID-------- 1580
TASDEVIL          NLL---LN-TVVLSV-PLSGTCQKNLINFSHGEYFYSLFSEVINTELLKNLD-------- 1583
HUMAN             SLL---LN-PAVLST-ASLGSSQGSVIHFSHGEYFYSLFSETINTELLKNLD-------- 1576
MOUSE             SLL---LN-SAMLST-QYLGSSQR-NISFSHGEYFYSLFSEVINSELLKNLD-------- 1573
CRASSO2           MCI---LD-ESMVEGTAK-------GYSQSHGELMFTAFKTTVSVHLAKAMA-------- 1565
POMACEA           EGI---LD-IRIIQGLSL-------GIEYMLGDHFFTLFKTPISSHVAASS--------- 1572
TRICHOPLAX        RYL---LD-ETK--L-----YGDSNSATATLGMTLYYTFNSNINAFLAKVSN-------- 1559
NEMATOSTELLA      RRA---VN-ILLIQM-----ICFLFSDGSSVGAVFYTTFQASINTYLIKNAQ-------- 1569
PRIAPULA          SLL---FD-DTRLLGVSAK--------QTTKGSMFYSTFGHEINNHLVGMAT-------- 1582
SOFTCORAL         HCI---LN-KSCLADAKGS--------SSTVGMVFYQTFHNTIEHLLIKNSS-------- 1578
PISTILLATA        ESI---ME-DSND------------NPGSSCGCTFYRIFQTSINGFFIERAN-------- 1597
HEMICHOR          SCL---MN-KTPVKTGRVD------SSAGYCGLSFYSHFKVPINTQLAQHGQ-------- 1602
BELCHER           DCV---MN-KTPLMTGGGK------KSSTFQGMVFFSTFKSCICQQLIKTCA-------- 1602
STRONG            DCL---LE-TTPVVSSTRSLTSKLSASQTSLGVLFLTTYKQPIMDQLVKHGQ-------- 1603
STARFISH          SCL---LD-KTALFSGRS---------STSKGAVFYTTFKTKLNGEMAVQAQ-------- 1608
                                             *  :
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Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

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                                                                                                RYG70450.1
ARCHAEON          SDNLLHILSSSQHEPSRILLEDILSYISDQIACNPELVNYVVYTM-VP------------  1649
MUDCRAB           ----------------------LIVTTLLELVKEGKFLEVMSFNGMLLNTLIRNSELRK--  1583
SCORPION          ----------------------HFISSLMNNINKSKTTVLKILVGI-LDSIGKVKEFRY--  1597
SPONGE            ----------------------MAIDVLLKNAKTHPQQVSVILNLL-LEYVQKDFKINNNN  1617
CAPITELLA         ----------------------KFVPLLMRHLEANGETLSSVLIGI-AESVISDRPLRK--  1607
DANIO             ----------------------RSVPLLLSSANQNPSMVSVLLNGM-LDHSFRERSVRK--  1622
MILII             ----------------------SAVTQLMRSASENPKMVSTVLNGM-LDQSFRDHTVRK--  1619
BAMBOO            ----------------------SAVAQLMTSARENPKMVSAVLNGM-LDHSFRDHTVRK--  1618
XENOPUS           ----------------------TIVVELMKSSLEDPKMVSCVLNGM-LDQSFRQRTIRK--  1634
STERLET           ----------------------TTVAQLMKSAAENPKMVSMVLNGM-LDQSFRERSVRK--  1635
GAR               ----------------------STVPQLMSLAAENPKMVSAVLNGM-LDQSFRDRSVRE--  1622
LATIMERIA         ----------------------TAVSQLMNSAAENPKMVGAILNGL-LDQSFRNRTVRK--  1623
CAECIL            ----------------------TAILQLMKSSVDNPRMVGTILNGM-LDQCFRDRTVRK--  1625
SNAKE             ----------------------IAVLELMKSALDSPKMVSTVLNGM-LDQSFKDRATCK--  1623
CANARY            ----------------------VFIVRLMKSSISNPQMVGSILNGM-LDQSFRDRAVRK--  1614
OSTRICH           ----------------------VIILQLMESSVSNPQMVGSILNGM-LDQSFRERTIRK--  1584
GECKO             ----------------------VAVLHLLKSSLDSPKMVGTILNGM-LDQSFRDRAVHK--  1623
TURTLE            ----------------------VAILQLMKSSVDSPKMVGTILNGM-LDQSFRERAVRK--  1623
ALLIGATOR         ----------------------VAILQLMKSAVDNPRMVGTILNGM-LDQSFRERTVRK--  1581
PLATYPUS          ----------------------TAVLELMKSSVDNAKMVGTILNGM-LDQSFRDRIVRK--  1616
TASDEVIL          ----------------------TAILELMKSSVDNAKMVGAILNGM-LDQSFRDRAVRK--  1619
HUMAN             ----------------------LAVLELMQSSVDNTKMVSAVLNGM-LDQSFRERANQK--  1612
MOUSE             ----------------------IAVSRLMESSSDNPKMVSTVLNGM-LDTSFRDRAVQK--  1609
CRASSO2           ----------------------QAVPVLCEHAQKQCYRVMSILVTM-VDTVSKDKNLRK--  1601
POMACEA           ----------------------DVVSLLMNKATVDPHRVCNVLVAM-LENVAQDRRIRK--  1608
TRICHOPLAX        ----------------------RCLPMILDLAASKSFMISGILSGL-LDFILRDRGLRQ--  1595
NEMATOSTELLA      ----------------------SHIPQLVSMATSYSSHVCSILNSI-LDQFNRDKTSRK--  1605
PRIAPULA          ----------------------VLIPKVLDRINNRESVVMTILTDL-LDQVGKDRETRK--  1618
SOFTCORAL         ----------------------EHLPKILEYNRDEAQWVSSTVIAL-LDSMVKDKELRK--  1614
PISTILLATA        ----------------------IHMANILMKAASSPFLVLSLLNGI-LDQVIRDKILRT--  1633
HEMICHOR          ----------------------EVVPLLLRHVVADSTIVSTILNGL-LDHITNNRELRK--  1638
BELCHER           ----------------------ESLPVLLQQLTAEPVWVGSILHGL-LDHLAKDKTLRK--  1638
STRONG            ----------------------DTVYELSNRVREDRGTIGMIIYGL-LEHAVGNREIRK--  1639
STARFISH          ----------------------KVIPLLVREGGKDVTVVSSVLNGL-LDYLTSSREVRR--  1644
                                         :  :              .  :
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                RYG70450.1
ARCHAEON          ----------LLESRVNLTTL---SS---SAILQLATILAQVTAITSRLCEC----RA  1687
MUDCRAB           ---KHSVKVVQAFLHHWSTYSTEAGKSS---IHQESVLDLLSSLFLVDREGTMKAHCSAE  1637
SCORPION          ---RYGKDIINSIMCQWSRLQQCLEESC-DIDLQNDIITLITKMFLIDSSFIKGNVN-YD  1652
SPONGE            NNKETVETLCTELISHWQDLSLWWEDGS--KDLKSAAVTLLQKIIALKPKLLLKSAD--V  1673
CAPITELLA         ---SHGKMVSRAIVSQWSSLSVWWSESTASLDTKMVAITLLTKLMQIDSTVIIDVKN-KS  1663
DANIO             ---SQGSQLAEQVLKGWDLLRPWWDGPAATPESKTSVLSLLAKVLQIDSSVCSNTSH-PA  1678
MILII             ---TQGVLLVSAVLTNWTRLESWWSENS-SAESKMAVLTLLSKVLQIDSSVSFSSNH-EA  1674
BAMBOO            ---KQGIYLVSAVLSNWAKLDSWWSVKS-SPESKMAVLTLLSKVLQIDSSVSFGNSH-DA  1673
XENOPUS           ---QQGVKLVNAVLENWRRLDSWWYKDS-PSESKMAVLTLLAKVLQIDSSVCFDINH-SA  1689
STERLET           ---TQGSQLVGGVLGSWTSLQSWWASSS-SAESKMAALTLLSKVLQIDSSVSFNTSH-LA  1690
GAR               ---SQGRQLVKRVTQAWSSLGSWWSSPASTSESKMATLTLLSKVLQIDSSVCFNVNH-EA  1678
LATIMERIA         ---QQGSQLVDTVLQNWTKLSSWWIRSS-SPESKMAALTLLSKVLQIDSSVSFNPNH-AA  1678
CAECIL            ---QQGVKMVIAVLQNWKKLDSWWDKNS-APESKMAVLTLLAKVLQIDSSVSSNAHH-EA  1680
SNAKE             ---QQGVKLVAAILKNWGHLDHWWAKDA-SPESKMSVLTLLAKVLQIDSSVSFT-HH-EA  1677
CANARY            ---QQGAKLVTAVLRNWEKLDGWWAKGS-SAESKMALLTLLAKVLQIDSSVSFNTNH-EA  1669
OSTRICH           ---QQGVKLVTAVLRNWKRLDSWWAKGS-APESKMAVLTLLAKVLQIDSAVSFNTNH-EA  1639
GECKO             ---QQGVKLVNAILKNWVHLDNWRTRDS-APESKMAVLTLLAKVLQIDSSVSFSTQH-EA  1678
TURTLE            ---QQGIKLVTAVLRNWMRLDSWWAKDS-APESKMAVLTLLAKVLQIDSSVSFNTNH-EA  1678
ALLIGATOR         ---QQGMKLVTAVLRNWMRLDTWWAKDS-APESKMAVLTLLAKVLQVDSSVSFNTKH-EA  1636
PLATYPUS          ---QQGEKLVDAILQNWKRLDTWWAEDS-TPESKIAVLTLLAKVLQIDSSVSSNTNH-AA  1671
TASDEVIL          ---QQGMKLVATILQNWKKLDTWWAKDS-VPESKMAVLTLMAKILQIDSSVSFSINH-GA  1674
HUMAN             ---HQGLKLATTILQHWKKCDSWWAKDS-PLETKMAVLALLAKILQIDSSVSFNTSH-GS  1667
MOUSE             ---HQGLKLATAILQNWRKCDSWWAPDS-APESKTTVLSLLAKMLQIDSALSFDTNH-SS  1664
CRASSO2           ---QISANVVTSVVEKWKSISSWCLA-T--PELHSMAMLLLTKLVLLDSKVVTDSSS-GH  1654
POMACEA           ---SNGPRIVDMVASKWHHLESWWQAGS--SDLQGLAVLLLTKLLLVDSKAVLNVEK-SH  1662
TRICHOPLAX        ---SKGIHISKKILSSWNSLKCWWLTPD-AQDLLQISVNILNKCLTLDPQFATQSND-SS  1650
NEMATOSTELLA      ---RYGSVVCASIVNSWEVFSSLWDMSS-SSELKQALLEIMKKLLLSDPKCLIDPAK-PA  1660
PRIAPULA          ---RYGSGVVNTVLQCWGHLRDLWVATS-TPDRKDMLLMLLRKLLLIDSSVATKGSH-SA  1673
SOFTCORAL         ---MNGRKMTTVLLESWERLSHWWENGG-EEL-KRSTAILIRNILIVDPKCLSEVK---S  1666
PISTILLATA        ---RNGSSFVAVLLNNWTSFEIFWRTHS-AMDLRHSILMILKKMLILDPAKVTDCNR-LT  1688
HEMICHOR          ---KKGLTVHAAILSNWSSLKSWWSEGA-THDQRSSTLILLKKLLQIDSKFASDPTH-AA  1693
BELCHER           ---KEGAALCDSLLQSWPKLAPWWEEGA-LQDSKSTALTLLRKILIIDSQVSRDPAH-PA  1693
STRONG            ---RYGMAIYSAVLTQWDTLSNL-------GQEDDFMLNLMKKVLQIDFKFATDPTH-PT  1688
STARFISH          ---THGMSVHSAILTQWDILMGGLKKGC-STDLQSFALLMLRKLLQIDAKFVSDTTH-PV  1699
                                 .                          :: .
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                RYG70450.1
ARCHAEON          LRTYMLHELMLTFDNPKDVTKVVQCLSWLPLLLPGCTTSSSRSLSLVDMQGEAAELARVQ  1747
MUDCRAB           DAGVLKFYRRLLIEDKATLSMKNKALKLLPFFLT---------------MSKQVSKSIS  1681
SCORPION          SNSIFFSFITLLQKSEMSLEFKICVLDLLPFFLC-----------------DAFLCKVQ  1694
SPONGE            SKPLVDMYTAMIGDEKLELNFKAVMIDLLPSFLL-------------LSS-PEHQSQLK  1718
CAPITELLA         FYYVFKMFLGLISDKNNTLQFKTRVLDLLIFFCN---------------LPAEENKQLE  1707
DANIO             FNAVFTTFTALLTDVSMPLNLKSQALIMLPFFTA---------------LPSMPLEELR  1722
MILII             FAMVFHTYTTILTDSTLALNLKSQAMIILPFFAH---------------LPEENLAVLR  1718
BAMBOO            FSMVFQTYTTILTDSTLALNLKTKAVIILPFFTQ---------------LPEENLVTLK  1717
XENOPUS           FAEVFKTYTSILTDQKLGLNLKSQAIIILPFFTK---------------LTGEKLTELK  1733
STERLET           FAVVFSTYTTLVTDSTLPLNLKSQALIILPFFTN---------------LLGSTLADLH  1734
GAR               FEAVFTTYTALITDSALPLNLKNHGLIILPFFTN---------------LPESTLAELQ  1722
LATIMERIA         FPAVFNTYTTLLTDQTLALNLKSQAVIVLPFFTN---------------LPEDHLADLK  1722
CAECIL            FSAVFNTYTSILTDQKLGLNLKSQAIIILPFFTN---------------LTGDSLNDLK  1724
SNAKE             FPNVFNTYTCLLMDQKLGLHLKSQAIIILPFFTE---------------LVGEGLHKLK  1721
CANARY            FTAVFNTYTSLLTDQNLGLNLKGQAVIILPFFTN---------------LTGEKLNDLK  1713
OSTRICH           FTAVFSTYTSLLIDQNLDLNLKSQAMIILPFFTN---------------LTGEKLNDLK  1683
GECKO             FSDVFNTYTSLLTDQNLGLNLKSQAVIILPFFTN---------------LVGERLVDLK  1722
TURTLE            FSAVFNTYTSLLIDRNLGLNLKSQAVIILPFFTN---------------LTGDRISELK  1722
ALLIGATOR         FFAVFNTYTSLLVDQNLGLNLKSQAVVILPFFTN---------------LTGERLKELK  1680
PLATYPUS          FSAVFNAYTSLLIDKKLGLNLKSQAVLILPFFTN---------------LTGDRLNDLK  1715
TASDEVIL          FLDVFTTYTSLLDDPKLGLNLKGQALIILPFFTN---------------LTGERLEDLK  1718
HUMAN             FPEVFTTYISLLADTKLDLHLKGQAVTLLPFFTS---------------LTGGSLEELR  1711
MOUSE             FSEIFTTYASLLADTKLGLHLKGQAIILLPFFTS---------------LREGSLENLK  1708
CRASSO2           FPEVFETYLSMLTEKKTTLSVKCKILELLPFFAT---------------LPEPHLKKLK  1698
POMACEA           FTTVFTSYCTILAEKKTNLAFKNRALDVLPFFAA---------------VPDAKL---K  1703
TRICHOPLAX        FETVFNFFLSLLSGTSTSLAFKKYVLDLLHFFLV---------------SSDKRIRELR  1694
NEMATOSTELLA      FQIVLKMFTSVFDDKNLTLTFKSRAVELFPYFKN---------------LPDNYQSQLK  1704
PRIAPULA          HRDVYDTYCCLLVDAGTSLAFKTRVMELLHFYCE---------------LPEQETTKLR  1717
SOFTCORAL         SRGMFKTYNGLLKDKTITLTVKIQCLELLPCFTS-------------ATIPSEQTEALR  1712
PISTILLATA        FPSLFEMYLLYLKDKSTTLAFKGQVLELLPYFTK---------------STEEYLRRLK  1732
HEMICHOR          FKPVFDMYLNMVTDSNTSLAFKSRVLEILYFFTR---------------IPEQELSLLQ  1737
BELCHER           FQPVFTMYLDMLTDSRSTLPFKSQVLDLLPFFTV---------------LPQTQLAELK  1737
STRONG            FRPVFNQYLSMLRDSKKSLAWKTQVLDVLYFFAN---------------VPEKEEKELK  1732
STARFISH          FSSVLEAYSFMLTDASTSLTFKAQVMDVLFFFTS---------------LPDGEQTKLR  1743
                                  :       :   :
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                              RYG70450.1
ARCHAEON        EGLENLVSTRFPLDSSQLPVSSSQGKEFLVILEAYLQAFQACGSVIMLPPLYPALREGK-  1806
MUDCRAB         EDLEMVSFKHFPMQSSEFPVGGSRDRDYHQALSEILTALELSLSLELLKFILQVFCNED-  1740
SCORPION        AALNDLFTNHFPLYSSELKPGSSQYNDYHLAFTKLLIALELTGNEMLLKFVIQIMCRES-  1753
SPONGE          GSLNRLVSLQFPLTSSELPAGGPLLNEYTNIIEKLCNSLVASGSLVLLELIINIMCREV-  1777
CAPITELLA       SCLNQFVADCFPMSSLEFHAGSQQQKCYITALDRLLLAMELSGSLMLLNLIISVICKEV-  1766
DANIO           RALESLVATHFPMQSDEFPRGSLQCNNYMDCIRKFLEALQLSQSPLLLKLMARVLCRDK-  1781
MILII           HALDQFVAAHFPMKSDEFPKGTLKYNNYVDAIKKLLDALELSQSPMLLKLMIAILCRDS-  1777
BAMBOO          NALNHFIASHFPMKSDEFPKGTLRYNNYVDCVKKLLDALELSQSPLLLQILTEVLCRDN-  1776
XENOPUS         NTLDQFVASNFPMKSDEFPKGTLKFNNYVDCIKKFLDALELSQSPMLLQLMTEILCRDE-  1792
STERLET         NALEVLVASHFPMQSDEFPKGTLRYNNYIDSIKKFLDALELSQSPMLLKLMTGILCRDN-  1793
GAR             RALEMLVASHFPISSDEFPKGTLRYNNYVDTIKKFLDALELSQNPMLLKLMAEILCRDK-  1781
LATIMERIA       NALDQLVAFNFPMKSDEFPKGTLKYNNYVDCIKKFLDALELSQSPMLLRLMTEILCRDS-  1781
CAECIL          NALDQLVAFNFPLKSDEFPKGTLKYNNYVDCVKKFLDALELSQSTMLLKLMTEILCRDT-  1783
SNAKE           HALDQLVAYNFPLTSDEFPKGTLKYNNYVDCVKKFLDALELSQNSTLLELMTEILCRDN-  1780
CANARY          NALDQLVAFNFPMRSDEFPKGTLKHNNYVDCTKKFLDALELSQSPMLLQLMTEILCRDN-  1772
OSTRICH         NALDQLIAFNFPMRSDEFPKGTLKHNNYVDCTKKFLDALELSQSPMLLQLMTEVLCRDH-  1742
GECKO           NVLDQFVAFNFPLRSNEFPKGTLRYNNFVDCTKKFLDALELSQSPMLLQLMTEILCRDH-  1781
TURTLE          NALDQLVAFNFPMKSDEFPKGTLRYNNYVDCTKKFLDALELSQSPMLLQLMTEILCRDH-  1781
ALLIGATOR       DALDQLVAFNFPMKSDEFPKGTLRYNNYVDCTKKFLDALELSQSPLLLQLMTEILCRDH-  1739
PLATYPUS        NALEQFVAFNFPMNSDEFPKGTLRYNNYVDCTKKFLDALELSQSPMLLQLMTEILCRDQ-  1774
TASDEVIL        LALEKLVASNFPMTSHEFVQGTLKYNNYVDCTKKFLDALELSQSPMLLQFMTEILCRDQ-  1777
HUMAN           RVLEQLIVAHFPMQSREFPPGTPRFNNYVDCMKKFLDALELSQSPMLLELMTEVLCREQ-  1770
MOUSE           HILEKLIVCNFPMKSDEFPPDSLKYNNYVDCMKKFLDALELSQSPMLFQLMTDILCREQ-  1767
CRASSO2         RSLDRLVADHFPIKSTDLPESSPHFKDYIAAIDRLLTSLELSGSEMLLELLISIFCREP-  1757
POMACEA         DVLDGLVADNFPLRSSELTKGTPRFVDYISAIDKLLSALELSSSLVLLELLISIFCREEG  1763
TRICHOPLAX      EHLDRMIVDKFPLKSAEFVVGSPDYNDYVACIDKLLANLIKSGNLMLLEVLISVMCREK-  1753
NEMATOSTELLA    SCIDTLVTDNFPLKSTEFIPGSPRYNDYIATLDKLLVTMVTSGSLVLLQVITAVLCREE-  1763
PRIAPULA        ENLDRMVADFFPLRSSDFIVGSPKYHDYVAAMSQLLDVMEVSGSTMLLRLVISIVCRES-  1776
SOFTCORAL       SALKTLIADNFPLSSKEFNENNPKYSDYIAALDKILSALVISGSLMLFDLLISIVCREE-  1771
PISTILLATA      EGLNAFVTNNIPLKSTEFVTGGPQYNDYVQTIDKLLAAFVNSRSLILLEVLIAIFCRER-  1791
HEMICHOR        GRLNRLIADNFPLKSSEFVVGSPKYNDYVAAFGKILSALVISGSLMLLELLISIMCREP-  1796
BELCHER         ARLDRMVADNFPLKSAEFPAGSSKYNDYVGAVTKLLSALELSSSLMLLELLISVMCREA-  1796
STRONG          SALDLLVANHFPLKSTDLEAGSPRYNDYIMALNKILTSLVMSGSLMLLELIISILCRDD-  1791
STARFISH        SALDRLVADNFPLNSSEFRVGSPKYIDYAGALNKILTAMVLSGNLMLLEIVISIMCRDE-  1802
                  :. .    :*: * ::  .      :          :    .  ::  :   . .
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Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                                    RYG70450.1
ARCHAEON            QHIYYQSFIKVISSVPKSLPSLPPTDTMEHSGSEHLYTEVKHICNFCLEVIYNVYQD---  1863
MUDCRAB             KHRYEEAFNESIEKFIKRQQVS--KQ-----------------IDTLRFVYDMYAN-QS  1779
SCORPION            THLLEENIQKCLKKLCKRTDSN--KE-----------------RLIAEVPLKMFLE-DE  1792
SPONGE              RHVCEEKIQTSLHQFISKLSED---G-----------------VDALKFVYEMFKN-DK  1815
CAPITELLA           KHTHENAIQSAFQRFIKRLPKD--KH-----------------KLALDVPYKIFSQ-EG  1805
DANIO               KHIMEELFQACFQKIAHQSYLG--KQ-----------------VLLLSSTYQSFQA-KE  1820
MILII               RHVMEEGFQVCFQRLAKTGSCE--KQ-----------------VALLEAVYGMFEN-EG  1816
BAMBOO              RHVMEEAFQICFQNIAKRGTCE--KQ-----------------VALLEAAYEMFRN-EE  1815
XENOPUS             RHFMEELFQSSFKKVIKRSSCD--TQ-----------------VILLNTLHNMFKS-ES  1831
STERLET             KHVMEELFQTCFKRIARRGSCE--KQ-----------------VSLLDTVYQMFQN-DE  1832
GAR                 KHVTEELFQACFKRIARRSGCE--RQ-----------------VVLLETVYEMFQA-GE  1820
LATIMERIA           KHCLEELFLRCFKKIVRRGSCD--RQ-----------------VTLLDTVYKMFQD-EG  1820
CAECIL              KHFMEELFLTSFKRIARRGNCD--KQ-----------------VALLETVHDMFKT-EN  1822
SNAKE               KHIMEELFEINLKRIAKRGSCE--RQ-----------------VLLLDTVHQMFQS-ET  1819
CANARY              RHFMEDLFQASFKRISRRSPTD--KQ-----------------VLLLDTVHKMFQS-EE  1811
OSTRICH             RHFMEGLFQASFKRISRRSNSD--RQ-----------------VVLLDTVHKMFQS-ED  1781
GECKO               RHIMEEQFEISFIRIARRGSCY--KQ-----------------VVLLDTVHKMFQS-ET  1820
TURTLE              RHFMEDLFQTSFKRISRRSSYE--KQ-----------------VVLLDTVHKMFQS-EA  1820
ALLIGATOR           RHCMEDLFQTSFKRVIKRSDCN--KQ-----------------VVLLDTVYKMFQS-ES  1778
PLATYPUS            RHFMEELFQMSFKRIARRSGSA--KQ-----------------VALLEAVHGMFLR-DD  1813
TASDEVIL            RHVIEELFQTTFQRISKRSSSA--TQ-----------------VALLDTVHRMFQK-DD  1816
HUMAN               QHVMEELFQSSFRRIARRGSCV--TQ-----------------VGLLESVYEMFRK-DD  1809
MOUSE               RHIMEELFQTTFKRIARQSPCV--TQ-----------------LNLLESVYTMFRK-AD  1806
CRASSO2             KHVYETKILESINRFTRRVPAA--KQ-----------------KSMVDVAYNIFCQ-EK  1796
POMACEA             RHVHEDAIQQSLNTFTARLPAE--KQ-----------------KDALDVPYKIVFC-ES  1802
TRICHOPLAX          KHAYEEQIQKSLLLFISSLIPKDA-------------------LGALDVPFKMFVD-DK  1792
NEMATOSTELLA        RHVHEEEIQKSLAAFIQRLAPSSSLV-----------------KGAVDVTYRIFTN-ER  1804
PRIAPULA            KHAMHDQLQTSLSRFIHRLSAD--KQ-----------------KLAADSGYSILAE-EG  1815
SOFTCORAL           SHSHEEEIQIQFAKFIKRLKLQ--QA-----------------RKALDICFDVFTKKDT  1811
PISTILLATA          QHVHEDQIQQSFIAFIQRLHPEPDQA-----------------KAAMDVCLSIFFN-ER  1832
HEMICHOR            KHVCEDQIQASLITFIKHLPAD--KQ-----------------KPAVDVAFDVFHK-EN  1835
BELCHER             KHVMEDDIQTSLSRFIKGMGAD--RQ-----------------KPALDIPYGIFRR-EG  1835
STRONG              KHSYEDKIQGALSSFAKRLPSE--KQ-----------------SAAANIPFEIFKQ-DK  1830
STARFISH            KHAYEDEIQESLAAFIKRLPEE--KQ-----------------TAAFGVAYQIFCQ-EN  1841
                     *     :   :  .
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Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                  RYG70450.1
ARCHAEON          ---VPIKRILLEFLLLPTLLSLSSKNMVVLFSLGYHRGLQIRMSSVSSDHSIIKVLHDII  1920
MUDCRAB           HLKQNLRYNIMEKVLIPLLQLSDLTVTVSFSIDV-----------------IKPVMAGM  1821
SCORPION          LYPSDMRIHIIEKVFRVILGMISKITLKYFFIDH-----------------IKEIMQIV  1834
SPONGE            DFPVAAVKGIGERLCVPLFTECSSAVLLEFFVLK-----------------ISDVMCIM  1857
CAPITELLA         RFTNNQRRAACEKVSLSLMRLVHSSALTEFYCEH-----------------IKEIMKII  1847
DANIO             VPSNFMLMGLIDRVLLPLASHCSPQALSQFFISN-----------------IADIMTTL  1862
MILII             GLSNIARQSVMDRSLLTLITHCSLDALKEFISKI-----------------IKDAMGIL  1858
BAMBOO            MLPNATRQFAMDRSLLTLIGHCSPDALREFFCKI-----------------VKDAMEIL  1857
XENOPUS           LMLNGTLQSLIDRCLLTLLWNCSLDAMISFFTNI-----------------ISLAMDTL  1873
STERLET           LHSNTARQAVLDRSLLTLTLHCSSDALKEFFCTT-----------------VGDIMGTL  1874
GAR               LASGAMRQAVLDRVLLTLVLHCSSDALRGFFCKT-----------------IASVMETL  1862
LATIMERIA         LLSNTTRQAIMDRTFLTIMLNCSIDALKEFLCKN-----------------ILDVMGTL  1862
CAECIL            LWSNTTRQTIVDKSLLILIWHCSLDALKEFFCKI-----------------IIHTMDTL  1864
SNAKE             LHSNITRQAYVDRCLLILLLHCSLDALKEFLSKI-----------------IIEAMDTL  1861
CANARY            LLSNAARQAFVDRSLLTLLWHCSLDALRVFFGKI-----------------IVEAMDTL  1853
OSTRICH           LRSNVTRQAFVDRSLLTLLLHCSLDALREFFGTI-----------------IVQAMDTL  1823
GECKO             LLSSATRQAYVDRSLLTLLLHCSTDALDDFFCKI-----------------IVEAMDSL  1862
TURTLE            LLSNATRQAFVDRSFLTLLLHCSLDALKDFFSKI-----------------VLEAMDTL  1862
ALLIGATOR         LLSNVTRQAFLDRSLLTLLLYCSLDALKEFFSKI-----------------VVEAMDTL  1820
PLATYPUS          HLSSTTRQAFVDRSLLTLLLHCSLDALKEFFYRI-----------------IVGAMDML  1855
TASDEVIL          -LSNIPRLACVDRCLLTLLWHCSLAALREFFSSI-----------------IVEALDVL  1857
HUMAN             PRLSFTRQSFVDRSLLTLLWHCSLDALREFFSTI-----------------VVDAIDVL  1851
MOUSE             LPSNVTRQAFVDRSLLTLLWHCDLDTLKEFFSRI-----------------VVDAIDVL  1848
CRASSO2           LYPGEVRRTTIEKVALPILRLVHKSALLEFFTDH-----------------MGDLRTTV  1838
POMACEA           GFQDMIRRTTLERVCLPILRCVHKAALIEFFLDH-----------------ILDLMRIV  1844
TRICHOPLAX        SYRPDIRRAAIERVCLPMLQKASLKITKDFYVSH-----------------IKEIMDII  1834
NEMATOSTELLA      DHTSNVRLAVLDRVSVTLLCNASKAGVSEFFSSH-----------------VKEIMEII  1846
PRIAPULA          NFPGEIRRSCLDNVVLLLLRQCCHHAVVEFFRCH-----------------LVEIIGII  1857
SOFTCORAL         EYRNLTRRAAIDKVCLVLLRASSTSVFREFYVDH-----------------IKNIMEII  1853
PISTILLATA        DYQTHSRRAVIERICITFLLKTSTTARRAFYQDQ-----------------IQKLMSVL  1874
HEMICHOR          VYPNDIRRAALERVGLPLLRLVDIPTLSTFFISH-----------------VNQIMNTI  1877
BELCHER           SFPNEIRRSALERVCLPMLRLVHPAALTEFFTDH-----------------IREIMDII  1877
STRONG            RYSKEIRKAAIQRVCIPLLRQASRDATVTFYKGH-----------------IHDIISVL  1872
STARFISH          SFSKEIRRAAIERVCIPLMRLAGVKALSSFFKEC-----------------IKNIGGII  1883
                             :                   :                       :      :
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Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                RYG70450.1
ARCHAEON          AGDIFPANMSDETLLSHVYMVTVAYKMLSLLYDHCYVGDVKL---TLTAAFVHGDMSNTV  1977
MUDCRAB           SLTIQ--GRS-DEQQRLLVTKIGSFKILQVIFSRLPRERIFNPGSEINAAYQPSD-----  1873
SCORPION          KSKRK--SS----NEIQLVSKIGAFQLIEILYTYLSKEEVS-KESQINC-----------  1876
SPONGE            EAKLA--RVTDPKLECQLVHKSCCFQFIEILYTRLPSSLISSMESTVNTAYCNGS-----  1910
CAPITELLA         EAKPT--KAPEHAFEAQLTSKIGCFELLEVMYSRLPNTDVNSKDSSINKSFCSPK----I  1901
DANIO             QTRFT--KSVESVFESQIMMKIGCCKLLEVLYSRLPKEEVYSKNSAINQAFCGTG----C  1916
MILII             QSRFT--KTSESSFDNQLTRKIGCYKLLEVTYIRLPKDDIYSEDSKINRAFHSSS----N  1912
BAMBOO            QSRFT--KTNESSFDNQLTKKIGCYKLFEVMYTRLPKNDVYTDGSKIIQAFHSAG----N  1911
XENOPUS           KSRFT--KVPEAAFDSQITKKWGYYKMLEVQYSRLSKDEIYST---VNNAYHVSS----K  1924
STERLET           QARFT--KSSESTFETQLTKKNGCYKLLEVLYSRLPKEDVYSKESLINQAFCRPN----K  1928
GAR               QARFT--KLNEAMFEGQLIKKNGCYKLLEVLYSRLPKEEVYSKESKINQGFCGPS----R  1916
LATIMERIA         QARFT--KSNESAFDTQVTKKTGCYKLLEVMCSRLPKDDIYSEQSRINQAFHGSC----S  1916
CAECIL            KGRFT--KSNELAFDAQIMMKMSYYKMLEVMYSRLTKEDIYSKGSRINQAFHGSS----N  1918
SNAKE             KSRFT--KSNETSFETQLIKKISYYKILEVMYSRLSKEDVHSKDSRINQVFQRST----H  1915
CANARY            NSRFT--KSHEHTFDTQVTKKMGYYKLLEVMYVRLSKEEVYSKDSKINQAYRGSM----S  1907
OSTRICH           NSRFT--KSNESTFDTQVTKKTGYYKVLEVMYVRLSKEDVYSKDSKINQAYCGSI----S  1877
GECKO             TSRFT--KSNETMFDTQLTKKMSYYKILEVMYSRLSKEDVYSKDSRINQAFLRST----C  1916
TURTLE            KTRFT--KSNESAFDTQVTKKMGYYKILEVMYSRLSKEDIYSKDSRINQAYQGST----N  1916
ALLIGATOR         KSRFT--KSNETVFNTQVIKKMGYYKILEVLYSRVSKEDVHSKDSQINQAYQGTT----N  1874
PLATYPUS          KSRFT--KSNESTFDTQVTKKLGYYKMLEMMYSRLPKDDVHSKESRINRAFHGSS----V  1909
TASDEVIL          KSRFT--KLSESTFDTQVTKKLGYYKMLEVLYSRLPKDDVHSKESRINQVFHGSS----I  1911
HUMAN             KSRFT--KLNESTFDTQITKKMGYYKILDVMYSRLPKDDVHAKESKINQVFHGSC----I  1905
MOUSE             KSRFT--KLNEFTFDTQITKKMCYYKMLAVMYSRLLKDDVHSKEAKINQAFHGSR----V  1902
CRASSO2           EAKLV--KGS--GLENQLTSKLCCFQLLELMYGRLSKEEVFGKSSVINKKFCEVKSV--N  1892
POMACEA           EQNLA--KGPESILKTQLTSKVCCFQLLEVMYSRLSREEVNSLSSEINKKVCFGK-----  1897
TRICHOPLAX        ETKLV--KTA--DLENQLISKLGSYKLMKLMYSKLSKQDVNTAESSIVKAYTGRP-----  1885
NEMATOSTELLA      EAKQL--KTYDPGFESQLVSKMCAFRMIEVLYSRLGKAELNSPQSSINLAYCPN------  1898
PRIAPULA          EAKVV--KLPERQYESQLISKICSLKLLELMYACLPKEDVYGKDAALGQVFLASR-----  1910
SOFTCORAL         ETRFS--KATDSVFESQLVSKLCCFKLLALLYARLEKTDVSSMESRINRAYNN-D-----  1905
PISTILLATA        EAKEL--KPTDPNFESQVTSKLCCFKLVEILYSQFSKSELNTLESTINKAYVGGD-----  1927
HEMICHOR          EAKQI--KVPESSFETQLVSKIGCFELMEVLYSRMTKEELNTPQSKVNKIYCRDS-----  1930
BELCHER           GAPQT--KAGEASLRTQLTNKLCCFQLLETMYSRLPKEEVNTPPSRIVRAYKGEE-----  1930
STRONG            EARLT--KNPVPAFENQLVSKICYFELIEVLYSRLSKDDLNSKDSALNREYRHGN-----  1925
STARFISH          DAKTI--KAPETVFQNQLVSKTCCFQLVELMYSRLVKEDLFSMDSAINKAYTN-D-----  1935
                                  :       ...           :      :
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Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

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                                                                                                RYG70450.1
ARCHAEON          NIKGSEL-TSAVLKVAHKFVRTQMSSIPNYYAYSIVSELKETLFELYAAAFSCLVTIVCK  2036
MUDCRAB           -TSGKEL-TKDVLRQSSKVAKGELRHDQ---------TQAEFRRLCACAAYNTLIAVLVC  1922
SCORPION          -SYGKEL-TREATGFAIAARKENLEGES---------ISKEFCRKYCCAAYNAVIAIICC  1925
SPONGE            PQTGKEL-TQAITKCCHGAKSEDLHGDR---------THYETRRQYHCHAYNTLMSVISC  1960
CAPITELLA         PDTGKEM-NLTITKVSNATKGENMNGET---------LLIPLRRALHCAAYNTLIAALIC  1951
DANIO             -AEGNEL-SKNLLKSCFEAFTENMTGEM---------VLLELRRQFHCAAYNCAIALISC  1965
MILII             -MEGNKLLSKSLLKLCYDAFTENMTGEK---------QLLEKRRQYHCAAYNCIMAVVTC  1962
BAMBOO            -IEGNKL-SKTLLKSCYDTVTENMTGET---------QLLEKRRQYHCAAYNCMIAILCC  1960
XENOPUS           -PEGNEL-TKALIKLCYDTFTENMCGET---------QLLEKRRQYHCAAYNCAISLISC  1973
STERLET           -AEGNEL-SKSLLKSCFDTFTENMAGET---------QLLEKRRKYHCAAYNCAITVISC  1977
GAR               AAEGNEL-SKTLLKSCFEAYTENMAGET---------QLLEERRQYHCAAYNCAIAVISC  1966
LATIMERIA         -AQRNGL-SKTLLKLCYDEFTENMAGET---------QLLEKRRQYHCAAYNCAIAVISC  1965
CAECIL            -AEGNEL-TKILVKSCYDSFSENMAGET---------QLFEKRRQYHCAAYNCAIAVISR  1967
SNAKE             -VEGNEL-TKLLIKSCYDAFTENMSGET---------QLLENRRQFHCAAYNCAIAVISC  1964
CANARY            -VEGNEL-TKTLIKSCYDAFTENMAGES---------QLLEKRRQYHCAAYNCAIAVISC  1956
OSTRICH           -VEGNEL-TKTLIKSCYDAFTENMAGES---------QLLEKRRQYHCAAYNCAIAVISC  1926
GECKO             -VEGNEL-TKTLIKSCYDAFTENMTGET---------QLLEKRRQYHCAAYNCAIAVISC  1965
TURTLE            -VEGNEL-TKTLIKSCYDAFTENMAGES---------QLLEKRRQYHCAAYNCAIAVISC  1965
ALLIGATOR         -VEGNEL-TKMLIKSCYDAFTENMAGES---------HLLGKRREYHCAAYNCAIAVISC  1923
PLATYPUS          -IEGNEL-TKTLIKSCYDAFTENMAGET---------QLLEKRRQYHCAAYNCAIAVISC  1958
TASDEVIL          -VEGNEL-TKTLIKLCYDAFTENMAGET---------QLLEKRRLYHCAAYNCAIAILCR  1960
HUMAN             -TEGNEL-TKTLIKLCYDAFTENMAGEN---------QLLERRRLYHCAAYNCAISVICC  1954
MOUSE             -AEGNEL-TKTLLKLCHDAFTENMVGES---------QLLEKRRLYHCAAYNCAISLISC  1951
CRASSO2           VDTGKEM-TQVIMRTAHEAKGEDVRGET---------SCVELRRQYHCAAYNLLIAVLSS  1942
POMACEA           PETGKEM-TQKIIKAANNAKSEDTRGDF---------MVTELRRQYHCYSYNLLIAIICC  1947
TRICHOPLAX        TEDGKEI-TKSITKAAHACKSDDLRGET---------RSVELHRQCCCAAYNALISVISS  1935
NEMATOSTELLA      DNTGKEL-TKAITKSAHAAKSEDMRGET---------VAFELRRQLHCAAYNALLALISC  1948
PRIAPULA          PAGSKEL-TPVITRLCYDACREDMRGER---------ALLELRRQYHCTAYNVCVASVSR  1960
SOFTCORAL         VKTGKEL-TMAITKAAHAAKSENMQGET---------VLLPLRREYHCSAYNALISVISR  1955
PISTILLATA        VKTGKEL-TLAITKAARAASIEDMRGET---------VALELRRQFHCAAYNALVALICC  1977
HEMICHOR          VKSGKEM-TMALTKIAHAAKGEDIRGES---------VLVELRRQYHCAAYNALVAIVSC  1980
BELCHER           VKAGNEM-TTAITKFGHAAKSEDLRGET---------GLLDLRREFHCAAYNALIAIISC  1980
STRONG            VEKGNEM-STALTKAALGARNEDCRGET---------VAVELRRQFHCAAFNCSAAIISC  1975
STARFISH          VKTGKEM-TQALTKACHAAKSEDIRGET---------NALELRRQFHCAAFNALIAIISC  1985
                       . : .             :                       . ::.   : :
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

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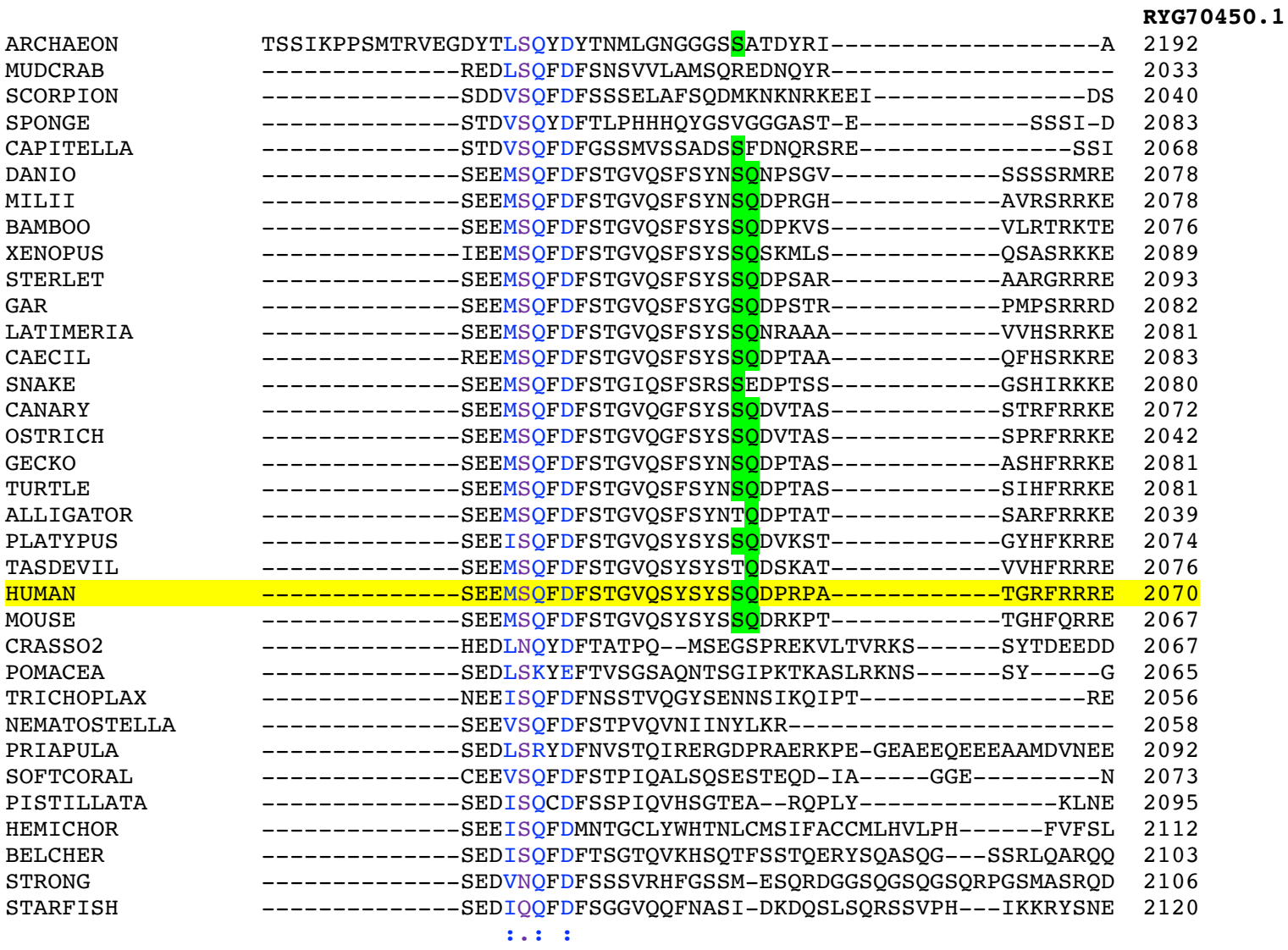
                                                                                                RYG70450.1
ARCHAEON          IYSQSDWAMRNREVNAVVTVQRLCTQAKKRLGKGGYASQYLQSCMLSSSQAVQSVAAPLQ  2151
MUDCRAB           ----------KNLKEANQS-SGKG--------AAGTVQYLASHYLDDSSL---------  2007
SCORPION          ----------HENRELNSN-KTLN--------FASSLKYAPSQYLSDSSL---------  2009
SPONGE            ----------DDLKQSTAA-GNSS--GSPSSSPSTRPRYISSQYLSDSSL---------  2051
CAPITELLA         ----------TSVRDVDPS-DEPT-------GPASSVHYLASQYLAGSSL---------  2037
DANIO             ----------KEVSG---E-NGDA----------PVYLSSQSYMADSSL---------  2044
MILII             ----------KEAREAGDG-DSGE----------PQYLSSQSYMADSSL---------  2044
BAMBOO            ----------KEARESAEG-DSDE----------PHYLSSQSYMVDSSL---------  2042
XENOPUS           ----------KEARDASST-ESDE----------PSYLSSQSYMADSSL---------  2055
STERLET           ----------KEARQGGEG-DSDE----------PHYLSSQSYMADSSL---------  2059
GAR               ----------KEAREAGDR-DAEE----------PHYLSSQSYMADSSL---------  2048
LATIMERIA         ----------KEARGSTIG-DLDE----------PQYMSSQSYMADSSL---------  2047
CAECIL            ----------QEARNTANG-ESDA----------PHYLSSQSYMADSSL---------  2049
SNAKE             ----------KEARQTMSG-DSAE----------PRYLASASYMVDSSL---------  2046
CANARY            ----------KEARDAGNS-SQDE----------PKYLASSSYMMDSSL---------  2038
OSTRICH           ----------KEARDSGNG-NEDE----------PKYLPSASYMMDSSL---------  2008
GECKO             ----------KDAREAMSV-DSAE----------PHYLASASYMADSSL---------  2047
TURTLE            ----------KEARDAVNR-DSDE----------PQYLPSASYMVDSSL---------  2047
ALLIGATOR         ----------KEARDTVNG-GPDE----------PQYLPSASYMVDSSL---------  2005
PLATYPUS          ----------KEARDSVND-NSDE----------PHYLSSLSSMADSSL---------  2040
TASDEVIL          ----------KEARDAANG-DSEG----------PHYLSSLSYMADSSL---------  2042
HUMAN             ----------KEAREAANG-DSDG----------PSYMSSLSYLADSTL---------  2036
MOUSE             ----------KEARDAANG-ASGS----------PHYMSSLSYLTDSSL---------  2033
CRASSO2           ----------NEVKESNSQ-NGEA------DEGESSSLHLASQYLADSSL---------  2029
POMACEA           ----------SEMQEKQS-----D------KDGAISSYHLASQYLTESSL---------  2030
TRICHOPLAX        ----------EQSRSSVSS-ESADE--ADSGIAMAPSYHLSSQYLADSSL---------  2026
NEMATOSTELLA      ----------INARVQS---DQVEE--AL--SQGRSVRYLSSQYLADSSL---------  2035
PRIAPULA          ----------TAVREIDRD-ADGQ------GAPLPSVHYLASQYLADSSL---------  2047
SOFTCORAL         ----------CEARATRMN-SSEN------YEHGVSLRYLSSQYLADSSL---------  2042
PISTILLATA        ----------R---IPSPK-ENSL--EESAGRTGLSIHYMYSQYLADSSL---------  2065
HEMICHOR          ----------KEVRDASEE-DDLQDSAVGL-YGTGGVRYLSSQYLADSSL---------  2072
BELCHER           ----------QELRGQDSP-EAG----------SSRY-MQSYLAGSSL---------  2060
STRONG            ----------TQARETNTP-EES-------GYVSGPAHYLSSQYLSDSSL---------  2061
STARFISH          ----------NQIQDTVAG-SSSQQSDSGIEMSGYTGRYLSTQYLANSSL---------  2078
                                                                  :  *
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"



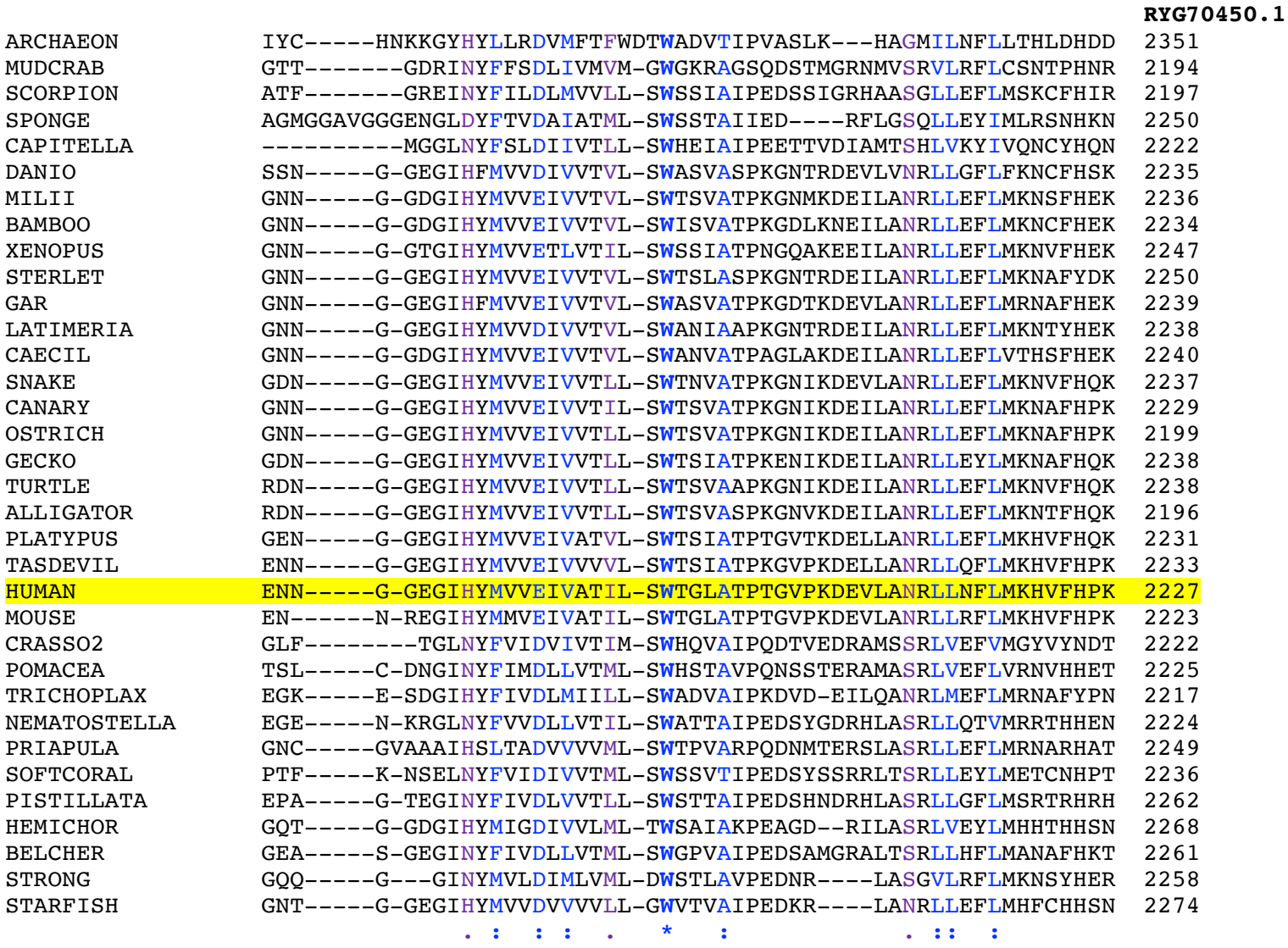
Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                RYG70450.1
ARCHAEON          FPNSAAVVAG-WDDQQVVLEMNHFNSIHIMGTLVRAIQRMYVLFK-----EKWIANTATL  2246
MUDCRAB           ---IAASNDETGELLRMNFEQSDYNEHEVMANLTAAIYHMVDAKIMMLHKEDSTPSAAEI  2090
SCORPION          NPSNEAKDDDLVSNITVELEIDDLNQHECMNSLTMLVQHMEKIQLL-----SSS--PKEI  2093
SPONGE            EDSGNSQEASSYVVSEEQLEEDDLNIHECMTPLMKLLDHMIINKITPAPSGD----SPEM  2139
CAPITELLA         EVPDVVLKEHY-----IEMEMDALNQHPCMAALSALLQHMKLNQITPEVEKGSK--PSSM  2121
DANIO             -RKEVLSQDET-----VELEMDELNQHECMANMTALLRHMQRNNITPKVEEGVR--PSDL  2130
MILII             QAELSVVQSDI-----MELEMDELNQHECMPAMIALINHMQRNNITPQVEEGKT--PQEL  2131
BAMBOO            WTESNIMLNDI-----VELEMDEMNQHECMATMTALIKHMQKTNITPKVEEGKT--PHEL  2129
XENOPUS           QITEGKTFDDV-----MEFEMDELNQHECMAAMTGLIKHMNRSEITPKVDEDAS--PQEL  2142
STERLET           -RVESLVQDDV-----VELEMDELNQHECMASMTALLNHMQRNNITPKVDEGTV--PADL  2145
GAR               -GAEAALQDDV-----VVLEMDELNQHECMASMTVLINHMQRNNITPEVEEGTV--PSDL  2134
LATIMERIA         -RTESVVQDDV-----MEFEMDELNQHECMAAMTALINHMQRNKITPQVEEESG--PVEL  2133
CAECIL            -HPEFTVQEDV-----MEFEMDELNQHECMAAMTGLIKYMQKTQITPKVEEGTV--PQDL  2135
SNAKE             -ITDTVVPGDM-----MELEMDELNQHECMTSMTTLLKHMHRNNITPVVEKDTN--SPEL  2132
CANARY            -PTEYKVLNDE-----MELEMDEFNQHECMASMTSLIKHMERNQITPKVEEGTV--PADL  2124
OSTRICH           -PTEYMALDDD-----TELEMDELNQHECMASMTTLIKHMQRNQITPKVEDGTV--PVDL  2094
GECKO             -PTESMGLGDI-----MELEMDELNQHECMASMTTLIKHMHRNNITPTVEKGAV--LPDL  2133
TURTLE            -PTESMDPDDL-----MELEMDELNQHECMASMTTLIKHMQRNQITPKVDEGIV--PRDL  2133
ALLIGATOR         -STESMVLDDE-----MELEMDELNQHECMTAMTTLIKHMQRNQITPQVDEGAV--SVAL  2091
PLATYPUS          -YRDPVTQSDV-----LELEMDELNQHECMATMTALIKHMQNNQITPKVEEGSG--STNL  2126
TASDEVIL          -RIDSMVQDDV-----MELEMDELNQHECMTTMTALIKHMQRNHITPHVKEGSE--PPSL  2128
HUMAN             -QRDPTVHDDV-----LELEMDELNRHECMAPLTALVKHMHRSLGPPQGEEDSV--PRDL  2122
MOUSE             -HQDSMTQDDI-----MELEMDELNQHECMAPMIALIKHMQRNVIAPKGEEGSI--PKDL  2119
CRASSO2           TDTKVMVEDDY-----VELEMDELNQHEGMANMIALLKHMQRAKIIPLVESG-V--VPEL  2119
POMACEA           GDNKVRLDGDY-----VELEMDALNSHECMAPLVALLKHIHKNNIFPAAQSDAS--SQDM  2118
TRICHOPLAX        TGDSEKAKTIINKFADEELELDDLNKHECMEALLTLLDHMAVNKINPAIEKDTT--PSEM  2114
NEMATOSTELLA      TGKPDQLG-EDSYEIGEDVEMDELNSHECLTKICSLLTHMKESNISPQPDKGAL--PKDM  2115
PRIAPULA          ESGSATLAGDY-----VEMEMDELNQHECMASMVALINHLATTVC--PIQAASS--PAHM  2143
SOFTCORAL         SGTPASPKESDSDISSEELEMDELNRHDCMTTLVGLINHLVKNKISPQPEQGKE--ANEM  2131
PISTILLATA        SSSTAEQTDDWYEVSEDTLEMDDLNRHESMAKMISLLKHLVDKKISPEQVKDVP--PTDM  2153
HEMICHOR          LPPSAFVKGDY-----LEMEMDELNLHECMSNMTALLKHMKRNKVTPEVAKGTV--PHEL  2165
BELCHER           QDSSVNIHGDF-----LEIEMDELNQHECMSSMSAVLQHMARNNITPQVQKGAA--PKDM  2156
STRONG            SKPVFSPGGEY-----LEMEEDALNQHECMAAMTGVLKHMTNNKINPDITKATK--AEEM  2159
STARFISH          ETPTVVVQGEY-----IEMESDALNQHECMASLTAVLKHMQANKITPEIPEGSK--ASEM  2173
                                  .* .  *    :  :   :  :                  :
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                RYG70450.1
ARCHAEON          PNWLKECYELV-LSS--KHKKAKMFILRLFINQPVATIIKPWLHLMLPGVLENIYS----  2299
MUDCRAB           PPWMTIIQQKLESGE--THRNVKLFLLRLMMNTS--RVFAPYAVHFINPVLTCLVD----  2142
SCORPION          PKWLDNLCKKLEDYS--VHRNIKLFLTKLFINNA--EIFKPYAVFLLQPLINLILN----  2145
SPONGE            PPWMTPLHKRMTDSR--TGRNIKLFIVRLITNRP--KIFQPYAKHWLPVLTQFILSGDST  2195
CAPITELLA         PDWMKNIHDKIKNSD--TQLNIRLFLAKVILNGE--SVFRPYASFWFQPLVALATN----  2173
DANIO             PPWMKFLQGKLDNPS--TPLNIRLFIAKLIINTE--EIFRPYAKHWLGPLMQLVVS----  2182
MILII             PPWMKFLHGKLGNSS--IPLNIRLFIAKLIVNSE--EVFRPYAKEWLGPLLQLVVS----  2183
BAMBOO            PPWMKFLHGKLGNSA--TPLNIRLFVAKLIVNTE--EIFQPYAKEWLGPLLQLVVS----  2181
XENOPUS           PSWMKFLHVKLGNTS--TPLNIRLFIAKLIVNTE--EVFRPYARFWIGPILQLIVS----  2194
STERLET           PPWMKFVHGKFGNAS--THLNIKLFIAKLIINTE--EVFRPYARHWLGPLLQLVVS----  2197
GAR               PPWMKFLQGKLGNPS--TQLNIRLFIAKLIVNKE--EVFRPYAKHWLWPLLQLVVS----  2186
LATIMERIA         PPWMKFLSHKLANPA--TPLNIRLFIAKLVINTE--EVFRPYAKHWLGPFLQLVVS----  2185
CAECIL            PPWMKFLHGKLGNTS--TPLNIRLFIAKLIANTE--DVFRPYAKQWLGPLLQLVVS----  2187
SNAKE             PPWMKFLHNKLGNST--VPLNIRLFVAKLIVNTE--EVFQPYAKWWLGPLLQLVVS----  2184
CANARY            PLWMKFLHGKLGNPS--VPLNIRLFIAKLIVNTE--DVFRPYAKHWLGPLLQLVVS----  2176
OSTRICH           PLWMKFLHGKLGNPS--VPLNIRLFIAKLIANTE--DVFRPYAKQWLGPLLQLVVS----  2146
GECKO             PPWMKFLHSKLGNPS--VPLNIRLFVAKLIVNTE--EVFQPYAKQFLGPLLQLIVS----  2185
TURTLE            PPWMKFIHGKLGNPS--MPLNIRLFLAKLIVNTE--EVFRPYARQWLGPLLQLVVS----  2185
ALLIGATOR         PPWMKFLHSKLGNPS--VPLNIRLFLAKLIVNTE--EVFRPYARHWLGPLLQLVVS----  2143
PLATYPUS          PPWMKFLHGKLANPL--GALNIRLFLAKLIANTE--EVFRPYARHWLGPLLQLVVS----  2178
TASDEVIL          PPWMKFLHNKLENPS--TPLNIRLFLAKLIINTE--EVFRPYAKHWLNPLLQLVVS----  2180
HUMAN             PSWMKFLHGKLGNPI--VPLNIRLFLAKLVINTE--EVFRPYAKHWLSPLLQLAAS----  2174
MOUSE             PPWMKFLHDKLGNAS--VSLNICLFLAKLVINTE--EVFRPYAKHWLSPLLQLAVC----  2171
CRASSO2           PAWMKNLNDKLRSPR--THNNIKYFITKLIINTA--EIFRPYARDWIRPLTQLIIS----  2171
POMACEA           PQWMVFLHDKMTKNTGSDTLNIRLFIAKLIINTS--EIFQPFARLWLRPLCQLILS----  2172
TRICHOPLAX        PSWMVALRKKASDHT--TNRNIKLFIAKLIINRP--KIFRPYAKFWLVPLIQLIV-----  2165
NEMATOSTELLA      PSWMSALHKKLTNFE--THLNIQLFIAKVIINQS--QVFEPYARFWLSPLMELILKLIEE  2171
PRIAPULA          PAWMELLHGKFSHVE--TPLNVRVFIARLVVLCA--HAFRPCAASWLAPLMHLVVN----  2195
SOFTCORAL         PPWMSYLHKKLSHHS--SELNVRLFIAKLITNLP--EVFEPYAKFWLDSLMELILL----  2183
PISTILLATA        PAWMAPLHKKIASSS--THLNIRLFIAKLIINEA--KIFEAHAKFWFNPLMELILQIKDT  2209
HEMICHOR          PGYMSYLQKKLSGPS--TNPNVKLFIIKLIINAE--EVFRPYAKFWLAPLMEWILG----  2217
BELCHER           PPWMSCLNKKLGGSS--THKNVKLFLAKLIVNNE--EVFRPYARFWLSPLMEMIVR----  2208
STRONG            PQWMSGLQKKLSSQS--TEHNIKLFIVRLVINAQ--DVFQPYARFWLSPLMQFLAG----  2211
STARFISH          PGWMASLQKKLTSQS--THVNIKLFIARLIINNN--EVFTPYARFWLSGLLQLLIS----  2225
                  * ::                :   *: ::.       :       :   .
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"



Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

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                                                                                                RYG70450.1
ARCHAEON          PDVLKENLNSVCSIFPRWLQLYSTSQQKTRIYNIALPYVPLEVDAIIRLLNTAYTMTGGA  2411
MUDCRAB           ADVFRYNIDAVKSVVECWRAVLTV----------PYAII-----YSL----------  2226
SCORPION          KDVFRNNLEMIKTVVQCWKERLDI----------PTYII-----FES----------  2229
SPONGE            RSILRNNLEIVRTMVELWKDKIDI----------PTRVL-----YDQ----------  2282
CAPITELLA         RQIMRNNLEVLKTLVEAWKSTIRI----------PTQDI-----YEN----------  2254
DANIO             RAVFRHNLEIIRTVVECWKDCLTI----------PYDLI-----YER----------  2267
MILII             TAVFRHNLEIIKTVVECWKDCLSV----------PYSLI-----FSR----------  2268
BAMBOO            RVVFRHNLEIIKTVVECWKDCLSI----------PYSLI-----FDR----------  2266
XENOPUS           RAVFRHNLEIIKTVLECWKECLSI----------PYRLI-----YEG----------  2279
STERLET           RAVFRHNLEIIKTVIECWKDCLAV----------PYSLI-----FDR----------  2282
GAR               RAVFRHNLEIIKTVVECWKDSLMV----------PYSLI-----FDR----------  2271
LATIMERIA         RAVFRHNLEIIKTVVECWKDCLAV----------PYSLL-----YQR----------  2270
CAECIL            RAVFRHNLEIIKTVVECWKDCLSI----------PYRLI-----FER----------  2272
SNAKE             RAVFRHNLEIIKTVIECWKDCLSI----------PYRII-----FQL----------  2269
CANARY            RAVFRHNLEIIKTVIECWKDCLSI----------PYSLI-----FQR----------  2261
OSTRICH           RAVFRHNLEIIKTVIECWKNCLSI----------PYSLI-----FEK----------  2231
GECKO             RAVFRHNLEIIKTVVECWKDCLSI----------PYRII-----FER----------  2270
TURTLE            RAVFRHNLEIIKTVVECWKDCLSI----------PYRLI-----FEQ----------  2270
ALLIGATOR         RAVFRHNLEIIKTVVECWKDCLTV----------PYRLI-----FEQ----------  2228
PLATYPUS          RAVFRHNLEIIKTVVECWKDCLSI----------PYRLI-----FEK----------  2263
TASDEVIL          RAVFRHNLEIIKTVVECWKDCLSI----------PYRII-----FEK----------  2265
HUMAN             RAVFRHNLEIIKTLVECWKDCLSI----------PYRLI-----FEK----------  2259
MOUSE             RAVFRHNLEIIKTLVECWKECLSI----------PYRLI-----FEK----------  2255
CRASSO2           RPVYRNNLELLKTLLQVWKDRVEI----------PYNIV-----YKH----------  2254
POMACEA           RAIFRNNLEMLKTLLECWKDCIEI----------PYQEV-----YNQ----------  2257
TRICHOPLAX        RSVLRNNIEIIKTAVELWKNHIEI----------PYRII-----YKN----------  2249
NEMATOSTELLA      RAVFKNNLEIVKTMVEVWRERVTV----------PTKVI-----YEA----------  2256
PRIAPULA          MSVFRNNLEIIKTLVECWRDRVDV----------PSQVI-----YEN----------  2281
SOFTCORAL         RSIFKNNLEVIKTFVEVWKERIDV----------PYKLI-----YER----------  2268
PISTILLATA        RSLFRNNLEIVKSVVEIWKSILHV----------PAEVI-----FNS----------  2294
HEMICHOR          RQVLRNNLEMVKTVVELWRDCIEV----------PSRVI-----FEA----------  2300
BELCHER           RAVMRNNLELIKTAVECWKTRVEV----------PTKVI-----HDQ----------  2293
STRONG            KSVMKNNLEVIKTLVECWKDVIDV----------PTRVI-----YES----------  2290
STARFISH          RQVLRNNLEMIKTLVECWKEIISV----------PTSVI-----YRI----------  2306
                    : : *:: : : .  *                 *   :
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

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                                                                                                RYG70450.1
ARCHAEON          HGSIYSTGSIAVRYRLAALDVVHCLLDCNYPLLVDYTLVNNVLSNFGNPN--TNITTQAL  2469
MUDCRAB           ----MEVSDGRNKEQEAGLNLLGIMLANG-------------LAPY-TED--SVAEKTKC  2266
SCORPION          ----MRNLDTKVKDNIVGIQLFGIVVSNG-------------LDPY-QNT--SRIDKISY  2269
SPONGE            ----FSNSDKSTVSNLSGIQLVGIAVANE-------------LNPY-DTNTAGSLDQGLY  2324
CAPITELLA         ----FIDREDKGKRNVVGLQIVGVFLANG-------------LSPW-QPD--AEVSKDRF  2294
DANIO             ----FAGTDPNSKDNSVGIQLLGIVMANN-------------LPPY-DAA--CGIEHDRY  2307
MILII             ----FSSTDPNSKDNSVGIQLLGIVLANN-------------LSPY-VPK--CEIGYERY  2308
BAMBOO            ----FAGRDPNTKDNSVGIQLLGIVLANN-------------LPPY-DCK--CEIDSERF  2306
XENOPUS           ----FSGTDPNTKDNSVGIQLLGLALANN-------------FSPL-DPK--CGIDPERY  2319
STERLET           ----FSGKDPNSKNNSVGIQLLGIVLANN-------------LPPY-DPK--CGIDSESY  2322
GAR               ----FAGSDPNSKDNSVGIQLLGIVLANN-------------LPPY-DPS--CGIEHERY  2311
LATIMERIA         ----FSGKDPNTKDNTVGIQLLGIILANN-------------LPPH-DPT--CSIDMESY  2310
CAECIL            ----FSNGNTNSKDNSVGIQLLGLILANN-------------LPPY-DPK--CGIDVERY  2312
SNAKE             ----FS-GDPNTKDNSVGIQLLGIVLANN-------------LPPY-DPK--CEIDSIRY  2308
CANARY            ----FSSGDPDTKDNSVGIQLLGIVLANN-------------LPPF-DPK--CEIDRVRY  2301
OSTRICH           ----FSGGDPNTKDNSVGIQLLGIVLAND-------------LPPF-DPK--CEIDRVRY  2271
GECKO             ----FSGGDPNTKDNSVGIQLLGIVLANN-------------LPPY-DPK--CEIDNVRY  2310
TURTLE            ----FSGGDPNTKDNSVGIQLLGIVLANN-------------LSPY-DPK--CEIDSVRY  2310
ALLIGATOR         ----FSGGDPDTKDNSVGIQLLGIVLANN-------------LPPY-DPK--CEIDSTRY  2268
PLATYPUS          ----FATGDPNTKDNSVGIQLLGIVLANN-------------LPPY-DPK--CGIDSARY  2303
TASDEVIL          ----FSNRDPNSKDNSVGIQLLGIIMANN-------------LPPY-DSK--SGIESTRY  2305
HUMAN             ----FSGKDPNSKDNSVGIQLLGIVMAND-------------LPPY-DPQ--CGIQSSEY  2299
MOUSE             ----FSHKDPNSKDNSVGIQLLGIVIANN-------------LPPY-DPN--CDITSAMY  2295
CRASSO2           ----LKQPDETKKESCVGIQLMGVVLSAK-------------FPPY-APT--APVDQEKF  2294
POMACEA           ----LKMPDPSSKSSLIGIQVLGVIMTCN-------------YAPY-GPS--ASVDRNRY  2297
TRICHOPLAX        ----FSNPDKDKKDNSTGIQCLGLVVANG-------------LSPY-RYD--VEVDEM--  2287
NEMATOSTELLA      ----LSNPHPDKKDNATGIQLLGVVLANK-------------IHPF-SSD--SSVDENTF  2296
PRIAPULA          ----MCAGDITMRDNSVGVQLLGVVVANN-------------LPPY-SHT--TAVDSEKF  2321
SOFTCORAL         ----FSNASVNTKENSVGIQLMGVIVANK-------------ITPF-KPG--CGVDEKRF  2308
PISTILLATA        ----FSDPDPVKKDNAVGIQLLGVVVANG-------------LFPV-TSD--STIDEDRF  2334
HEMICHOR          ----FSGKDPKGKENATGIQLLGVILSNQ-------------LPPY-RDT--CGIDKDRF  2340
BELCHER           ----LCGSDASSKANSVGIQLLGVVLANQ-------------LPPF-NPSTSGNIDREQF  2335
STRONG            ----LQDRSPDKKDSAVGIHLLGVILANN-------------LHPL-SPT--CDVDADRF  2330
STARFISH          ----LATPDPDVKDSSTGLQLLGIVLANG-------------LHPI-DKA--SDIDEERF  2346
                                  .:. .   :
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                RYG70450.1
ARCHAEON          LQAILDNLS-ISRKELVQSSCQVIGQILDLLNAHSMQAKQVLLYSQLGEFENKVVDIIDG  2528
MUDCRAB           EKILLKLLE-AHYASIYGAAAEVVGLVLKFQSSHSEDCN-------ETSFEENVARKVME  2318
SCORPION          LKTLTVNLK-NKYKEIYESASEVCGMSMKYYFDKDDDV--------YSEFCKIVKTEISS  2320
SPONGE            YKIFVNNLT-FKYKLIYAAAAEVLGMIMKRMAESYDPF--------LDRLEEMVGEQLFK  2375
CAPITELLA         YQYLAMNMN-QPDKQVYSASAEIVGMALSSLQNTESDKE------WCRAYGDNIQKMLLG  2347
DANIO             FQSLANNLSFIRYKEVYSAAAEVIGLILNYMTERENQI--------EGTLFNITVTKLMD  2359
MILII             FQRLVYNISLTRYKEVYAAAAEVLGLVLHYFAENEKQV--------DGLVHDLIAKELKQ  2360
BAMBOO            FQRLVHNISLTRYKEVYAAAAEVLGLVLQYLAG--KPM--------DCAVHDLVVKELQQ  2356
XENOPUS           FQSLANNLGLTRFKEVYIAAAEVIGLVLRYIVQNEKRT--------EAPVFDYVVKELKR  2371
STERLET           FQALATNISFGRFKDIYAAAAEVIGLIMQYLAKNEKQL--------EGPIFDFTVKELKH  2374
GAR               FKSLANNISFVRYKDIHVAAAEVIGLVMQYMAEKEKQS--------EGPIFDFTAHHLKK  2363
LATIMERIA         VKALANNLSFTRYKEVYAAAAEVLGLVLQYRAEKEKEL--------GGPIIDSVVRELKQ  2362
CAECIL            FQALANNIALTKYKDIYLAAAEVLGLALHYVAEKEKTL--------EGPLFDCVIKELKQ  2364
SNAKE             FQALSNNIALIRYKEVYVAAAEVLGLILQYIAEKENTF--------EGPIYDMVIKQLKL  2360
CANARY            FQALTSNMGLLKYREVYAAAAEVLGLALQYIAERENIL--------EDPVYDCVIKQLKH  2353
OSTRICH           FQALISNMGLLKYKEVYAAAAEVLGLALRYVAERENIL--------EDPAYDCVIKQLKH  2323
GECKO             FQALANNMALVRYKEVYAAAAEVLGLVLQYIAEKENIY--------ESPVFDIIIKQLKQ  2362
TURTLE            FQDLANNMSLIRYKEVYAAAAEVLGLILQYMAEKENIF--------EGPVYDCVIKRIEQ  2362
ALLIGATOR         FQALVNNMALLKYKEVYAAAAEVLGLTLRYIAEKENIT--------EGPIYDCVVKQLKQ  2320
PLATYPUS          FQALANNLSLVKYKEVYAAAAEVLGLTLQYVSEKETML--------EDSICELIVKQLKQ  2355
TASDEVIL          FQALVNNMSFIKYKEVYAAAAEVLGLILQYIAKKENVL--------EDSVFELVVKQLKQ  2357
HUMAN             FQALVNNMSFVRYKEVYAAAAEVLGLILRYVMERKNIL--------EESLCELVAKQLKQ  2351
MOUSE             FEALVNNMSFVKYKEVYAAAAEVLGLILQYITERKHVI--------AELVCELVIKQLKQ  2347
CRASSO2           FTTVAQYMR-NRYKAVYAATAEVVGMIFKHLAEKDRQT--------EGTFHDYVVNLMNS  2345
POMACEA           FTTLASSMT-NSSKMIFAAAAEVVGMVFAYLADKENET--------DGQFHSHVESVL--  2346
TRICHOPLAX        -LALAENLQ-FKYKEVYEAVAEVLGMIMKHLASVKKET--------EGPIFDYVTQHLSS  2337
NEMATOSTELLA      YTALSDNLT-FKYKDVHAPAAEVSGMLMKYLIEERKVT--------ECSLIALVEAKLSP  2347
PRIAPULA          FQAIVRCLA-NKYKEVYAAAAEVLGMILHRMVEREDEEA-------EGALRDAVVTAMST  2373
SOFTCORAL         YQDLVKNLS-FKYKDVHGAAAEVIGMILKYLSEENDKES-------CDGLSGLLNEKLSS  2360
PISTILLATA        YGTLVNNLT-FKYKDVHAAAAEVIGLLMMQLAKVKKIF--------DGPLHDMVGQKLLS  2385
HEMICHOR          YTTLSANLS-FKYKDVYAASAEVVGV-MKYMAEKEKVT--------DGTFHDNVFREISS  2390
BELCHER           FSAVAKNLQLTRYKDVYAAAAEVIGMIMKYMADVEKVT--------EGSFHTQVERYLLP  2387
STRONG            YSALASNID-NRYKAVHGAAAEVIGMAMKQMAENDKIT--------DGRLHEVTYKELSQ  2381
STARFISH          YAALSYNLK-NRYKMVHAAAAEVIGMAMKQKADVDKVT--------DGFLHSIVTSELTK  2397
                     .   :       :    .:: *  :                          :
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                  RYG70450.1
ARCHAEON          K-DKAKRGKETVVYCYKCILANYSGFLKREMICRPLLWFNSFTFQGRYSY--LEMLLRHN  2585
MUDCRAB           M---MHSKQGQGITVIYKIHLHFPAVLK-----------------RVMNRLLSVLPNLY  2357
SCORPION          L-----NAKDQYLTCLYKINTHFPIFID----------------SSFLNKILYMLPNVH  2358
SPONGE            LSQPLEKSEDKFITCLHKITLCYNKIVP-----------------RFVEKLLFLLPSLQ  2417
CAPITELLA         I---HGNKPDQFLTCVHCIQKHFSAFVE-----------------RFIHKVLFMLPGLY  2386
DANIO             LR--KKEVDDKFIVCLSKVSKHFPPLVD-----------------RFINPVFYLLPKLH  2399
MILII             LQ---QSKEDKFIVCLSKIVKNYPPFAD----------------RRFLNQVFYLLPKLH  2400
BAMBOO            LQ---NTKEDKFIVCLSKIVKHFPPFAD-----------------RFMNAVFFLMPKLY  2395
XENOPUS           HQ--TNNKEDKFIMCLNKVVKNFPPFAD-----------------RFMTIVLFLLPKLH  2411
STERLET           LQ---NTKEDKFVECLSKVVKNFPPLVD-----------------RFLNAVLFLLPKLH  2413
GAR               LQ---NEKEDKFVVCLSKVVKHFPPFMD-----------------RFVNAVFFLLPKMH  2402
LATIMERIA         LQ---SIKEDKFIVCLSKIVKNFALLAD-----------------RFMSVVFFLLPKLH  2401
CAECIL            HQ---NAKEDKFIMCLNKVVKNFSPLAD-----------------RFMTVVLFLLPKLH  2403
SNAKE             HQ---NTRDDKFIVCLNQITKNFPPLAD-----------------RFMSFVFFLLPKLH  2399
CANARY            HQ---NTQHDKFIQCLNKVVKNFPPLAD-----------------RFMNAVFFLIPKLH  2392
OSTRICH           HQ---NTQQDKFIQCLSKVVKSFPPLAD-----------------RFMSAVFFLIPKLH  2362
GECKO             HQ---NTREDKFIICLNKLAKNFPPLAD-----------------RFMNTVFFLIPKLH  2401
TURTLE            HQ---STKEDKFIVCLNKVAKNFPPLAD-----------------RFMNAVFFLIPKLH  2401
ALLIGATOR         HQ---NTKEDKFILCLNKVVKTFPPVAD-----------------RFINAVFFLLPKLH  2359
PLATYPUS          HQ---NSREDKFIVCLNKAVKNFPPLAD-----------------RFLNAVFFLLPKLH  2394
TASDEVIL          HQ---NTKEDKFIVCLNKAVKTFPPLAD-----------------RFMNAVFFLLPKFH  2396
HUMAN             HQ---NTMEDKFIVCLNKVTKSFPPLAD-----------------RFMNAVFFLLPKFH  2390
MOUSE             HQ---NTMEDKFIVCLNKIAKGFPPLAD-----------------RFLNALFFLLPKFH  2386
CRASSO2           L---QQSNPGNFLLCIHRMHLHYPPIAD-----------------RFMNRLLFVLPNLH  2384
POMACEA           ----GKVAPHNFLVCVHCIHRHYPPMAD-----------------RFLNKLLFMLPGLH  2384
TRICHOPLAX        MVSAGRMDVARFILCLYRVQLHYPIIAD-----------------RFVNKVLFLMPSLY  2379
NEMATOSTELLA      MATKGGKDIGKFITCVHRLQLNYPRIVD-----------------RFMKHIMFHLPTIH  2389
PRIAPULA          L---HADAKQNFIVCLQKMTLHYPAIADREVMTAVSDRYLGQVCGDRLMSKLLFMLPSLQ  2430
SOFTCORAL         ----MTKDLDKFILCVHQLQIHFPPIVD-----------------GFINQILFVFQHVH  2398
PISTILLATA        LVNRAKPELDKFITCVHKLKLNYPPIVD-----------------RFVNQILFTLPSVH  2427
HEMICHOR          S---QSSRPEVFITCIYKVQLYYKPFTD-----------------RFINKLLFMLPQIH  2429
BELCHER           L---QVNQQDVFLTCVHKIHLHFPPFAD-----------------RFVSKLLFMLPKLH  2426
STRONG            LH-LGSGKEVIFITCLHKIHLHYPVFTD-----------------RFMNKLLFMLPSIH  2422
STARFISH          I---SEIKPDVFVTCIHKLHFHYPEFAD-----------------HFTNKLLFMLPSLH  2436
                                :         :   .                         :   :
```

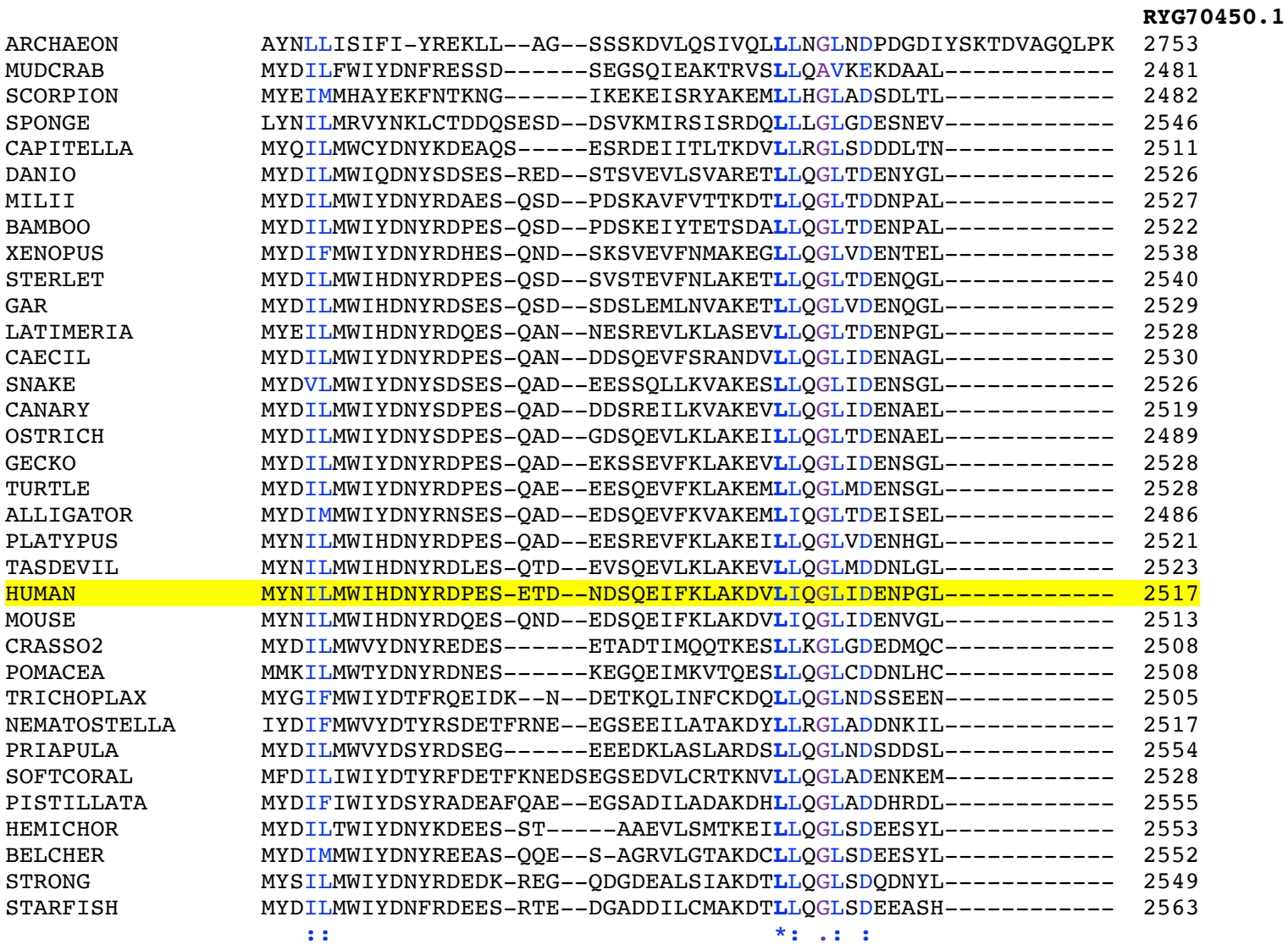
Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                  RYG70450.1
ARCHAEON          SIFVKSGTDCSHVMILELVRSFIKPMLVDRNVTAIGRGAGMVKIPLLQVYALILLTKHIQ  2645
MUDCRAB           GIF---CTRVLECL-----ASYSSS------------------ME--DIYSHLKEHNVLG  2389
SCORPION          GIF---RKQILEII-----NSHVEN------------------IE--NAFAELKNQGLLN  2390
SPONGE            GVF---RSSCLEIL-----DTQADV------------------QP--QFYLKLKDKGFHT  2449
CAPITELLA         GVF---RTYALEII-----AAGIEN------------------IE--GAFVEIKNKNIIG  2418
DANIO             GML---KTHCLECV-----LSRADV------------------IP--EIFLHLKTKGLSQ  2431
MILII             GVL---KTHCLEVV-----MHRAET------------------II--DIFQELKNKNFVQ  2432
BAMBOO            GIL---KTHCLEVV-----MYRAEE------------------IP--DIHIQLKSKDFTQ  2427
XENOPUS           GVL---KTQCLEII-----MHRAED------------------IP--DLFIELKNKDFCQ  2443
STERLET           GVL---KTHCMEIL-----MSRAEE------------------VT--DIYLQLKSKDFAQ  2445
GAR               GVL---KTHCLECI-----LSRAEE------------------IP--DVYLQLKSKDFSQ  2434
LATIMERIA         GVL---KTHCLEVV-----MSRAEE------------------IP--DIFLQLKSKDFIQ  2433
CAECIL            GVL---KTYCLEVV-----MCRAEE------------------IP--DLYIQLKSKDFNQ  2435
SNAKE             GVM---KTHCLEVV-----MCRAQE------------------IP--DMYLELKSKEFIQ  2431
CANARY            GVM---KTYCLEVI-----MCRAEE------------------VP--DLHLQLKSKDFIQ  2424
OSTRICH           GVM---KTHCLEVI-----MCRAEE------------------IT--DLHLQLKSKDFLQ  2394
GECKO             GVM---KTYCLEVV-----MGRAHG------------------IP--SLYLELKSKDFTQ  2433
TURTLE            GVL---KTYCLEVV-----MYRAEE------------------IT--DLYLQLKSKDFIQ  2433
ALLIGATOR         GVL---KTSCLEVV-----MCRAEE------------------IT--DLYLQLKSKDFMQ  2391
PLATYPUS          GVM---KTFCLEVV-----LCRAEE------------------IT--DLYLQLKSKDFAQ  2426
TASDEVIL          GVM---KTLCLEVV-----LCRAEE------------------IH--DLYLQLKSKDFIQ  2428
HUMAN             GVL---KTLCLEVV-----LCRVEG------------------MT--ELYFQLKSKDFVQ  2422
MOUSE             GVM---KTLCLEVV-----LCRAEE------------------IT--GLYLQLKSKDFLQ  2418
CRASSO2           AEF---RNRCLEIV-----LTRIDT------------------LE--NVYVELKSKGLLA  2416
POMACEA           GEF---RVQCLEVI-----MGCIEQ------------------LD--DAFRELQSKGLLN  2416
TRICHOPLAX        GEF---KTKCLEII-----LARADH------------------IK--ELYTELRNKGLKD  2411
NEMATOSTELLA      GVF---KAQCLEIV-----LSRVSD------------------IP--DLFTELRSKGLNV  2421
PRIAPULA          GSF---RSQCLEVI-----LTRVAH------------------TQ--NLFLELKSKGFLG  2462
SOFTCORAL         AQF---KTLCLEII-----LSRVGV------------------IP--NLFLELKTKGFLN  2430
PISTILLATA        GDF---KSYCLEIL-----CSRVEH------------------IP--NLFTELKGRGLKE  2459
HEMICHOR          GQP---KTYALEVV-----LGRVDS------------------ID--KIFLEMKNKRILE  2461
BELCHER           GIF---RTHCLEVI-----RGRVNV------------------ID--NLFLELKTRNFLG  2458
STRONG            GQP---KTECLQII-----TARIEH------------------ID--NAFIEMKNKNILA  2454
STARFISH          GQP---KTLCLEVV-----ASRVSH------------------IP--NIFLEMKSKGIVE  2468
                  .          . :                                .   :
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                  RYG70450.1
ARCHAEON            HICNTSEGRQDPETKQHNETVLQEVLISIIGKDETVAVRYCINA-------NNHVSVRYA  2698
MUDCRAB             LLSKKEESTQLV---------SLELVNAVLPRLTPSQVLYFLPG-ITGFASHPGAKCREM  2439
SCORPION            MLEHRDESIQFS---------SLNIIQKLLKELDIDKMLNVFPI-ISKVHKSAETICRKV  2440
SPONGE              MISHRDEATQTA---------SLSIVQKLLVQLTNDQLSEIVPILIASFSKHGSIQCRIV  2500
CAPITELLA           ILRERDELSQLM---------SLKIIRRLLEKLEASQLLYLLPA-ICEISDLSSVLCRRE  2468
DANIO               IMSHKDEGRQRV---------CLDIIHKILACLKPEELKEILGA-VTAFASHPSPVCRER  2481
MILII               IMSYSDEERQRI---------CLDIVYKIIAKLKAEEVKVFLVP-VIAFISHPSPVCRER  2482
BAMBOO              IMSHRDEDRQRV---------CLDIIYRIKAKLKSAELKELLRS-VVAFISHPSPICRER  2477
XENOPUS             IMNNRDDERQRV---------CLDIIYKILSKLTPAELHEFLIP-VTAFSSHSFPVCRER  2493
STERLET             IMSHRDEMRQRV---------CLDIVHKILAKLKPVELKELLIS-VTAFTTHPSPVCRER  2495
GAR                 VMSHRDEARQRV---------CLDIIHKIMAKLKPVEMREMLGA-VTSFVTHPSPVCRER  2484
LATIMERIA           LMNHRDDARQRV---------CLDIVYKIMFKLKPVEMKEFLVA-VTGFISHPSTVCRER  2483
CAECIL              IMSHRDDDRQKV---------CLDIIYKMLPKLKPMELGELLNT-VVTFSSHPSPMCRER  2485
SNAKE               VMCHRDDERQRI---------CLNIVYKMLPKLKPAEVLELLPS-VTGFISHPSPLCRGQ  2481
CANARY              IMNHRDDERQRV---------CLDIVHKMLSKLKPLELKELLPG-VTGFISHPSVMCRQR  2474
OSTRICH             IMNHRDDERQRV---------CLDIVYKMLPKLKPLELKELLPG-VTGFISHPTVICRQR  2444
GECKO               IMSHRDDERQTV---------CLDIVYKMLAKLTPAEVQELLPT-VTGFITHPSPLCRGR  2483
TURTLE              VMSHRDDERQRV---------CLDIVYKMLPKLKPLELRELLPG-VTGFISHPSPVCRER  2483
ALLIGATOR           VMNRRDDERQRV---------CLDIIYKMLSKLKPLELRELLPG-VTGFISHPSPVCRER  2441
PLATYPUS            VMRHRDDERQRV---------CLDIIYKMLAKLKPGELRELLNV-VVEFISHPSPVCREQ  2476
TASDEVIL            IMRHRDDERQKV---------CLDIIYTMLAKLKPVELQELLNC-VVEFISHPSPVCREK  2478
HUMAN               VMRHRDDERQKV---------CLDIIYKMMPKLKPVELRELLNP-VVEFVSHPSTTCREQ  2472
MOUSE               VMRHRDDERQKV---------CLDIVYKMVAKLKPIELRELLNP-VVEFVSHPSPTCREQ  2468
CRASSO2             FLTHRDDETQVI---------ALKIVKSIQSKLQPSEVSELLPL-ICGFCVSPSIPCRNV  2466
POMACEA             FLTQRDEDTQIV---------ALGIVNAMVPKLSATELQTFLPA-ITGFSNHPSVTCRQI  2466
TRICHOPLAX          MLLHRDESKQQV---------SLDLVRAMLKNLDISQILYLAEL-VATFKTNPSAACRQK  2461
NEMATOSTELLA        MFEHRDEGVQVA---------LLKIIQGLLEKLKMSEIEYVVPS-IATMATSSSTACREL  2471
PRIAPULA            MITHRDEATQLA---------SLHITNALLSSLSPGELLFLLPA-VTSIGTHPRAPCRQL  2512
SOFTCORAL           TLTHRDEATQVA---------CLRIILGRLSQMSVGDIQTLLPS-VTDFLSSKSVACRGL  2480
PISTILLATA          MLSQRDDGIQIG---------VLRIIKHLMKKLTIPELKFIFPL-LTSFVSHPNLLCRDL  2509
HEMICHOR            MLRHRDETIQLV---------SLKIVNSMLKRLNEEELLYLMPT-VVSFSKNLSPACRET  2511
BELCHER             MLTHRDDGLQAI---------VLQIVYALLQKLKVEELLYLLPS-VAAFASHPAPECRRT  2508
STRONG              LLTHKDEADQLT---------SLKLVDGMLPKLKPSELRYLLPA-VKDFVSHPSPSCRDT  2504
STARFISH            LLTHRDEGTQLV---------SLKLVNAMLPNLKPDEILYLLPP-VRTVFNLPSPACREV  2518
                     :   .:  *             :            :                   *
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"



Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                RYG70450.1
ARCHAEON          DSNILDSISNDSIQKYISPAYWSKRS--PRKQIKQLIYEFFQGYYLINCVN---IGQGLH  2808
MUDCRAB           --------------RQTVLNFWLERFQ-DMVLHDRVLHI-LKMIYSPETEDSF-------  2518
SCORPION          --------------RLTVHNFWSQNNHLPAETFSRIKAV-LQKMYSPEIEHMFSSDECFT  2527
SPONGE            --------------KLKMYEYWNQESNLSSNTLDRLTQL-LVTLYSKKTETQF-------  2584
CAPITELLA         --------------RLTVQNFWSHETRLPGETVERLVAM-LEAMYTPSTELHY-------  2549
DANIO             --------------QLYVRNFWSHESRLPPETLERMLVV-LKSLYSSRIEEQF-------  2564
MILII             --------------QLYVRNFWGHENRLPTGTHDRLMAI-LRSMYSNKIETQY-------  2565
BAMBOO            --------------QLYVRNFWSHENRLPTGTLDRMLAS-LGSLYCNKIETQY-------  2560
XENOPUS           --------------QLIVRNFWSDETRLPSNTTERMLAI-LSSLYSPKIEKHY-------  2576
STERLET           --------------QLYVRNFWSHESRLPTSTLERMLVV-LRSLYSSKIEAHY-------  2578
GAR               --------------QLYVRNFWSHETRLPTTTLERMLVI-LRSLYSSKIEAQY-------  2567
LATIMERIA         --------------QLYVRNFWSDENRLPVGTLDRMLVI-LKAFYCNKIETQY-------  2566
CAECIL            --------------QLTVRNFWSDETRLPVVTTDRMLAL-LNSFYSPKIESHY-------  2568
SNAKE             --------------QLIVRNFWSDETRLPTNTLDRMLSL-LRGLYSDKIETQY-------  2564
CANARY            --------------QLIVRNFWSHETRLPTNTLDRMLSL-LSSFYSTKIETHY-------  2557
OSTRICH           --------------QLIVRNFWSDETRLPANILDRMLAL-LNSFYSTKIETQY-------  2527
GECKO             --------------QLIVRNFWGDETRLPGNTLDRMLTL-LSSLYSTKTETQY-------  2566
TURTLE            --------------QLIVRNFWSDETRLPTNTLDRMLAL-LNSLYSTKIETQY-------  2566
ALLIGATOR         --------------QLVVRNFWSDETRLPTNTLDRMLAL-LNSFYSTKTETQY-------  2524
PLATYPUS          --------------QLIVRNFWSNETRLPSNILDRMLA--LNSFYSTKIEMHY-------  2558
TASDEVIL          --------------QLIIRNFWSHETRLPSNILDRLLA--LRSLYSTKIEMHF-------  2560
HUMAN             --------------QLIIRNFWSHETRLPSNTLDRLLA--LNSLYSPKIEVHF-------  2554
MOUSE             --------------QLIIRNFWSHETRLPSNTLDRLLA--LNSLYSPKIEVHF-------  2550
CRASSO2           --------------RLLVQNFWSSETRVPGNTLDRLVAM-LEAMYSPVTEKQF-------  2546
POMACEA           --------------RLTMQNFWSSESRLPDGTVDRMISI-LEAMYTPGSECNY-------  2546
TRICHOPLAX        --------------RLQLINFWSNNNRLPSGTLERLSSV-LYALYSPNAESEF-------  2543
NEMATOSTELLA      --------------KLKLQNFWSDETRLPNTTLERLVDV-LRAMYSTNTEQQY-------  2555
PRIAPULA          --------------RMIVTNFWSHATRLPTQTLPRLLAI-AQTLYSPATEPHF-------  2592
SOFTCORAL         --------------RLKLRNFWSDETRLPNSTLERLVQV-LRAMYSPITESEY-------  2566
PISTILLATA        --------------QLKLRNFWSDEARLPGTTLERLVEV-LRALYSTTTEIQY-------  2593
HEMICHOR          --------------RLRVSNFWSHETRLPVGTLDRMVSM-LECMYSPDAENQF-------  2591
BELCHER           --------------RLLVQNFWSHETRLPTGTLERLVAM-LECMHSPRTEPQY-------  2590
STRONG            --------------RLRVSNFWSHETRLPKETLERLISM-LGCMYSPGTENRY-------  2587
STARFISH          --------------RLRVSNFWSHETRLPTGTLERLVAM-LECMYSPGTEHQY-------  2601
                                 :     :*            ::        :
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                RYG70450.1
ARCHAEON          GYIILLCKE------------LFDIKSVNNWLAYAPSLLLSVILQHPKNLEVLFNISLL  2855
MUDCRAB           --------------------------------LELAMYIILEATRYSADYQRDIFQHPLT  2546
SCORPION          LYISLIVDNFWSNEKRLPLGTVERLIALMKNMLQYSTFLLMEMTSKSPDYNLKIFQNPLS  2587
SPONGE            --------------------------------LYHATNLLLELTSRSPDYNRVLFDTPLS  2612
CAPITELLA         --------------------------------LSYATNLLLEMTTKSSDFNRVLFDTPLS  2577
DANIO             --------------------------------LSLATDLLLEMTSHSPDFTRNMFEFPLS  2592
MILII             --------------------------------LSIATNLLLEMTSRSPDYTREMFEYPLS  2593
BAMBOO            --------------------------------LSIATNVLLEMTSHSPDYSREMFEYPLS  2588
XENOPUS           --------------------------------LSLATNLLLEMTSKSPDYIRKMFEHPLS  2604
STERLET           --------------------------------LSLATNLLLEMTSRSPDYTRDMFEYPLS  2606
GAR               --------------------------------LSLATNLLLEMTSRSPDYSRAIFEYPLS  2595
LATIMERIA         --------------------------------LSLATNLMLEMTSRSPDYTREIFEHPLS  2594
CAECIL            --------------------------------LSLATNFLLEMTSKSPDYTREMFEHALS  2596
SNAKE             --------------------------------LSLATNFLLEMTSKSPDYSRKMFEYPLS  2592
CANARY            --------------------------------LSLITNFLLEMTSKSPDYSRKIFEHPLS  2585
OSTRICH           --------------------------------LSLITNFLLEMTSKSPDYSRKMFEHPLS  2555
GECKO             --------------------------------LSLVTNFLLEMTSKSPDYSRKMFEYPLS  2594
TURTLE            --------------------------------LSLATNFLLEMTSKSPDYSRKMFEHPLS  2594
ALLIGATOR         --------------------------------LSLATNFLLEMTSKSPDYSRKIFEHPLS  2552
PLATYPUS          --------------------------------LSLVTNFLLEMTSKSPDYSRHIFEHPLS  2586
TASDEVIL          --------------------------------LSLATNFLLEMTSKSPDYSRHIFEHPLS  2588
HUMAN             --------------------------------LSLATNFLLEMTSMSPDYPNPMFEHPLS  2582
MOUSE             --------------------------------LSLATNFLLEMTRMSPDYLNPIFEHPLS  2578
CRASSO2           --------------------------------LSYATNLVLEMTSKSPDYQREMFESPLE  2574
POMACEA           --------------------------------LSYATNLLLEMTSKSPDYDRQIFEHPLS  2574
TRICHOPLAX        --------------------------------LSYSTNLILELTSRSPDYKLSIFDHPLS  2571
NEMATOSTELLA      --------------------------------LSYTTNLVLHLTSFSPDFERLMFEQPLS  2583
PRIAPULA          --------------------------------LSYATYLLLQLTSLSPDYKELVFTQPLS  2620
SOFTCORAL         --------------------------------LSYTTNLLLHLTSQSPDFGRLIFEQPLS  2594
PISTILLATA        --------------------------------LSYTTNLILHLTSLSPDYERLMFEQPLS  2621
HEMICHOR          --------------------------------LSYATSLLLEMTSKSPDYKREIFEHALS  2619
BELCHER           --------------------------------LSYCTNLLLEMTSRSPDFSREIFQHPLS  2618
STRONG            --------------------------------LGYATNLLLEMTSKSPDFKREIFEHPLS  2615
STARFISH          --------------------------------LSYASSLLLEMTSKSPDYKREIFEHPLS  2629
                                                  *     .::       .    :*   *
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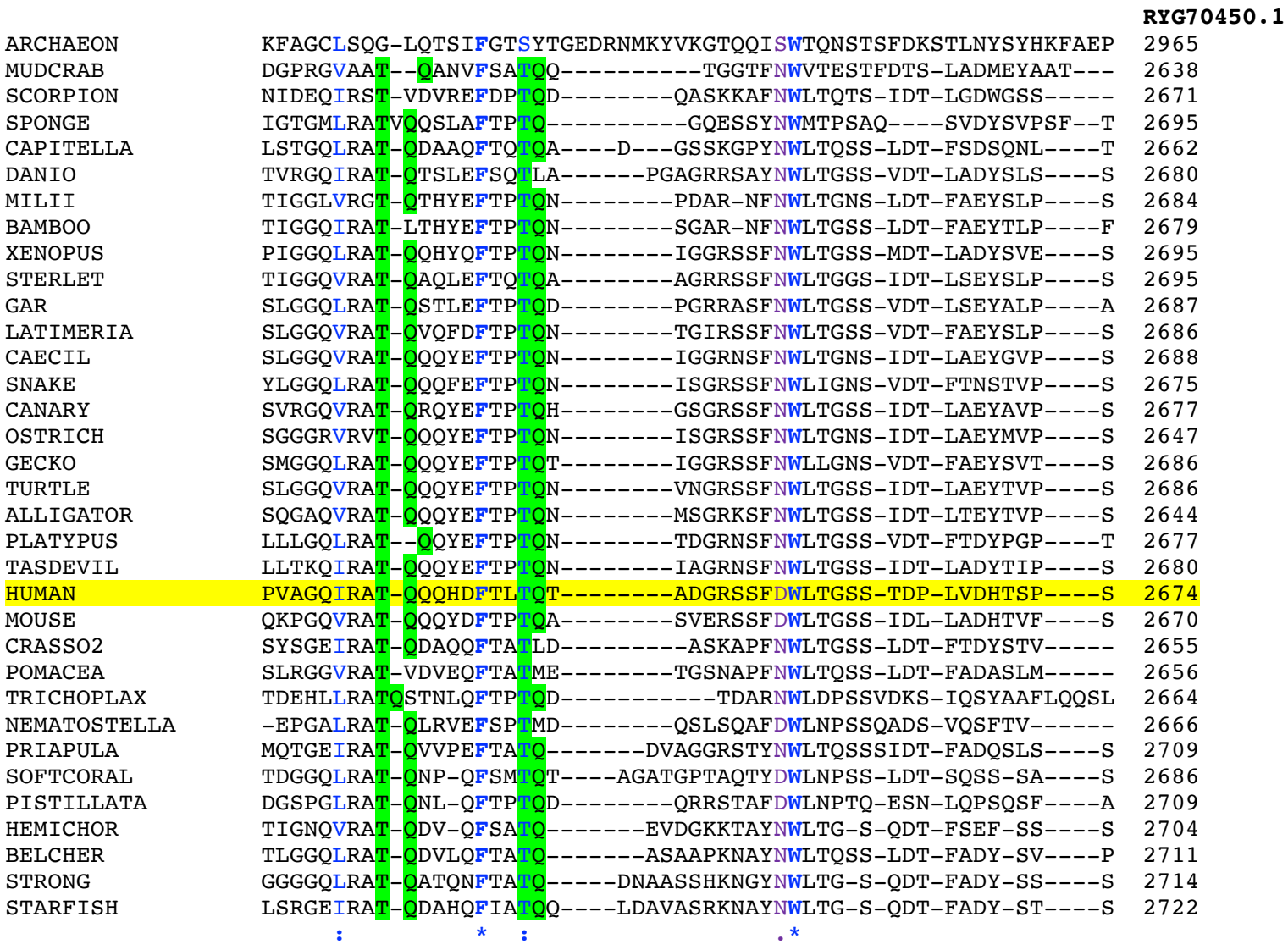
Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                                RYG70450.1
ARCHAEON          DNVTPTYQPLST-RSSRLTSSAGFSSSTPLFALERTSQSIQMLALQSPSIA--------K  2906
MUDCRAB           LCKFREMK-VSTAWRAR-----HASM-IPLFMDTQVSSDSSLRSLTQ-----SNEAEDDV  2594
SCORPION          TCAFQNYA-ISSSWKKR-----HATL-TPWFVDSLSSAASFSDTSV-------------K  2627
SPONGE            ECRFEDYKEIDLSWQQR-----HLQM-TPLFAATQLSQTQSDTG---------------S  2651
CAPITELLA         ECKFQDFA-VSSTWYQR-----HAAM-TPMFLDTQSSQSNDSPD--------------AG  2616
DANIO             ECKFQDYT-IDSNWRMR-----STVL-TPMFMETQATQGAEAAGSQ------------AA  2633
MILII             ECKFQDYN-IDSSWQQR-----STIL-TPMFVETQATQNSSRSQSQ------EGSLTAQG  2640
BAMBOO            ECKFQDYS-IDSSWHQR-----SRIL-TPLFVETQASAGSIKRSSQ------EASTVDQN  2635
XENOPUS           ECKFQDYT-VDSSWRFR-----SSVL-TPMFVETQLSQSMQRSRAQ-------GTIEADE  2650
STERLET           DCKFQDYI-IDSNWRHR-----STVL-TPMFVETQVTQGGTQYHTQ------D---SPQG  2650
GAR               ECKFHDYI-IDSSWHHR-----NTVL-TPMFVETQASQGGSRYQSR------GGSASAQG  2642
LATIMERIA         ECKFQDYI-IDSNWRHR-----STVL-TPMFVETQASQSTARFRSQ------EGPEQVQG  2641
CAECIL            ECKFQDYT-IDSNWRYH-----STVL-TPMFVETQASLSASRYRSQ------EGSFPAQS  2643
SNAKE             ECKFQDFV-IDSNWRYR-----STIL-TPMFVETRASQSA---------------ITQEG  2630
CANARY            ECKFQDFV-VDSSWRYR-----STVL-TPMFVETQASPSTHRNLSQ------ERSLSPSG  2632
OSTRICH           ECKFQDFV-IDSSWRYR-----STVL-TPLFVETQASQSTNRSLLQ------ERSPSTSG  2602
GECKO             ECKFQEFA-VDSSWRFR-----STVL-TPMFVETQASQNPSRHRPP------GGSLLTHG  2641
TURTLE            ECRFQDFT-IDSNWRYR-----STVL-TPMFVETQATQSAKRNRSQ------EGSLSTQG  2641
ALLIGATOR         ECRFQDFI-IDSNWRYR-----STIL-TPMFVETQASQSASRKRSQ------EGSLSTPG  2599
PLATYPUS          ECKFQEYT-IDSNWRFR-----STVL-TPMFVETQASQSALRSRSQ------EGLLPGQG  2633
TASDEVIL          DCKFQEYS-IDSDWRYR-----STVL-TPMFIETQASQNSTRNRSQ------EGSLSLPR  2635
HUMAN             ECEFQEYT-IDSDWRFR-----STVL-TPMFVETQASQGTLQTRTQ------EGSLSARW  2629
MOUSE             ECEFQEYT-IDPDWRFR-----STVL-TPMFIETQASPSILHTQTQ------EGPLSDQR  2625
CRASSO2           DCKFQDYN-VKSSWKQR-----HAAM-TPLFANTMATQSMMDDD---------------E  2612
POMACEA           ECTFRDYS-VQSSWRQR-----HAVM-TPLFAVTQGSETMEDVE---------------D  2612
TRICHOPLAX        ECKFHDYN-VNYSWQYR-----HAMM-TPLFAATQLGSQGSMAS--------FSLSGSSS  2616
NEMATOSTELLA      ECKFEEYP-IDYSWQQR-----HVVM-TPLFAATQGSTQSHSQ------------GGSL-  2623
PRIAPULA          DCKFQDYN-IATSWQSR-----HAAL-TPLFTETQASQASSTQQTV-----------AAA  2662
SOFTCORAL         ECKFQDYE-INFAWQQR-----NSTM-TPLFVSTLMPSGSSQSS--------FGSHSMDI  2639
PISTILLATA        ECRFEEYQ-IDYSWQKR-----HLAM-TPLFAATQGSHGSGMTPT-----Q----ESMSV  2665
HEMICHOR          ECKFEDYQ-IDHSWKRR-----HAAISTPMFVETQSTQIGSDSQ------------SFIE  2661
BELCHER           ECRFQDVQ-IDHSWKQR-----HVAM-TPMFVETQSSHPASSQSQA-----QSLSQGGQD  2666
STRONG            ACKFEGVQ-IDHSWRQR-----HAAISTPKFVETQVGQSQGSI-RGSPSSQSMTSSGMSM  2668
STARFISH          ECRFQDVT-IDHSWKQR-----HLAISTPMFVETQSSQASSGSQSQSPPDS--------S  2675
                           :     :           * *
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"



Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                  RYG70450.1
ARCHAEON          T------GTTKLVSGAASSSVA-----PLS---SFPFQTTVGGGGISQP--GT--FS-MG  3006
MUDCRAB           HAPIHGSASGPMFNVGAHGKKNMNRY----------KKSSIGNTCMQPA---------ET  2679
SCORPION          -----STSSSLLFTIGSDTKKIP---------------NIDENNRNSN------QDTSK  2704
SPONGE            VGATPTSDSSLLFTRPTMRPPLK--------NPLR-----ISAERLGKV--GE---SEG-  2736
CAPITELLA         LATQ--SESSLMFTVGSSRIKS----------SKKTPGSEFGQRKVRSD---------VR  2701
DANIO             ---DS-LSSLLVFDKKRSERPQ---------AAWRAVGAGFGSKRLTAT--SD--DTDSR  2723
MILII             LASEP-GSSSLLVFSRWSERLH----R----PAKKPVGPDFGKKRLALP--GD--EVDSK  2731
BAMBOO            S--ES-ASSSLLVYSKRSERSQ----K----P-MKPVGPDFGQKRLAIP--GD--EVDAK  2723
XENOPUS           --PES-LPSALLFVNKRNENVR----R----VPLKPLGPNFGMRRLGLP--GD--VTDSK  2740
STERLET           S-ADS-VSSSLLVFGKRGDKSQ----Q----AARKPVGSDFGKKRLGLP--GD--EVDSR  2741
GAR               T-SDS-LSSSLLVFGKWGEKQQ----QQQQRGPKKPVGADFGKKRLALP--GD--EVDSR  2737
LATIMERIA         S-SES-LASSLLAYGKRSEKSQ----R----AAMKPVGPDFGKRRLALP--GD--EVDSR  2732
CAECIL            S-SES-LSSSLLFASKKSEKSR----R----TSLKPLGPNFGKKRLGLP--GD--EVDSK  2734
SNAKE             S-SES-V--SMLLIKKRTDRSY----K----TAFKPLSPNFGKKRQGLP--GD--EVDNK  2719
CANARY            S-SES-LSSSMLLVSKRSEKFK----Q----ATFKPVGPDFGKKRLGLP--GD--EVDSK  2723
OSTRICH           F-SES-LSSSMLLVSKRSEKFK----Q----SAFKPVGPDFGKKRLGLP--GD--EVDSK  2693
GECKO             S-SES-LSSSMLLTHKHADRSQ----R----AAFKPLGPNFGEKRLGLP--GD--EVDSK  2732
TURTLE            S-SES-LSSSMLFVSKRSEKSQ----R----ATLKPLGPNFGKKRLGLP--GD--EVDSK  2732
ALLIGATOR         S-SES-LSSSMLFVNKRSEKSQ----R----GTLKPVGPNFGKKKLGLP--GD--EVDST  2690
PLATYPUS          S-SES-LS-TLLFTHKKSSRTQ----K----AGFKPLGPNFGKKRVGLP--GD--EVDSK  2722
TASDEVIL          L-SES-LSSSLLFVHKRTDKPQ----R----AAWKSVGPNFGKKRLGLP--GD--EVDNK  2726
HUMAN             -------SDSLLFAHKRSERLQ----R----APLKSVGPDFGKKRLGLP--GD--EVDNK  2715
MOUSE             --SET-LSSSLLFSHKRTEKSQ----R----MSCKSVGPDFGTKKLGLP--DD--EVDNQ  2715
CRASSO2           ---GSETSSSLLFTVGTQDMALRTGLK-----PKRKPGPGFGRPR-----AGASSKPAE-  2701
POMACEA           ---ETNSLSSLLFTVGSSSKGADSKTRVATRHHHTGTGSNFGKQMARTERTGNSAGPK--  2711
TRICHOPLAX        SSTSSETSSTLLFLSSKSPRQR-----PLQ---MKPLSKDFGQQKLSSETA-S--QPQS-  2712
NEMATOSTELLA      --GSSEAQSSLLF--GTKPRAS-----QRS---LKPVPHDFGSRRLAPTQS-D--SQQA-  2710
PRIAPULA          VSSISSSSSSSPYSSPSAD-HH----------ETPTEAK----RR--GATGE--EPRE-  2748
SOFTCORAL         FSVGS-QPSSLLFKSNPNMRRF------KT---LRPQSEQPST-----SSAAQ--SDDP-  2728
PISTILLATA        MASTQ-TQSLLLFSTSQSHKRR------KM---LKPVPGDFGSQKLSQASSSR--ISSH-  2756
HEMICHOR          TGTET-SQSSLLFTIGTTKKKA------IT---RKPVSSGFGKDKMGAG--KD--QTDS-  2749
BELCHER           LGTE--TQSSLLFTTDASKKVAKARR-------LKPVGPGFGSDRLSAG--RD--QTDG-  2757
STRONG            SS-A--SESSLLFTMGSLPKRTAQGFRGVK------QDAGAGGSRD----------KEA-  2754
STARFISH          SA-S--DQSSLLFTLGASKKM-GRGRQGVS---KTATDAGFGKEKLQSDQPRG--RDEV-  2772
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                  RYG70450.1
ARCHAEON            PPTSLPRYMTTQRLPVRFSAHSMQQAQSSIINKM-IYRRTMTAEEAQNKHMSDVYNVDLH  3065
MUDCRAB             STTTDSGNIQSKLLRKRFYKDQDREKQTIFFAKQEERRNKMRATLEMERKLRREAQVTMY  2739
SCORPION            NKIEKLSSSNTFHLRRRFLKDREK--SRLHFIRMEMRKQQLRQEREKEQKKQREGQVTIY  2762
SPONGE              GETKEEKRKQVLQLKKRALKDKEM--VSSFFAMNEARKKMRREELKKQRRAARQSYVVMY  2794
CAPITELLA           VSAMDEANKEIMRLKRRFIHDQES--TARFFMKRNVRMKKMREDIQREQKMKREHQVTMY  2759
DANIO               TAAERERRADILRLRRRFLKDKEK--ESIKFAKKEIHSQRTERERRADLKIRQDAQVTLY  2781
MILII               TKGIVDQRADILRLRRRFLKDREK--VSLIFAKRGIREQRAEQKIKTEKRMERDAKVTLY  2789
BAMBOO              TKAVADQRADILRLRRRFLKDRQK--ENLIFARKSIQEKHLAKEMKTEQLKKRDAQVTLY  2781
XENOPUS             TK-SMEDRSDILRLRRRFLKDREK--LSLIYARKGTAEQKREKAIKIEQKMKQDAQITLY  2797
STERLET             TK-VKDQRADILRLRRRFLKDQEK--VSLIYAKKGVREQKQAKENVAEQKLKREAQVTLY  2798
GAR                 KKAVNDQRADILRLRRRFLKDQEK--VSLQFARKGIQAQRQEKERAAEQTLRREAQVTLY  2795
LATIMERIA           TK-VADQRLDILRLRRRFLKDQEK--VSLIYARKGVQIQKEEQKMKAELKMKQDAQVTLY  2789
CAECIL              AK-GIDDRSDILRLRRRFLKDQGQ--ISKIFVRKGVAEQKREKEITAERKMKRDSEVTLY  2791
SNAKE               SK-DTDEHTEILRLRRRFLKDKEK--LSLIYARKGVAEQKQEKEIKTQLKIKHDAQITLY  2776
CANARY              TK-GIEERAEILRLRRRFLKDQDK--LSLIYARKSLAEQKREKEIKSELKMKYDAQVTLY  2780
OSTRICH             IK-GIDERAEILKLRRRFLKDQEK--LSLIYARKGVAEQKREKEMKSELKMKHDGQVILY  2750
GECKO               TK-GIDERAEILRLRRRFLKDQEK--LSLIYARKGVAELKQEKELKTELKMKHDAQVTLY  2789
TURTLE              AK-GIDERAEILRLRRRFLKDQEK--LSLIYARKGVAEQKREKEIKSELKMKHDAQVTLY  2789
ALLIGATOR           TK-DINERAEILRLRRRFLKDQEK--LSVIYARKGVAEQKREKEIKTELTMKRDAQVTLY  2747
PLATYPUS            TK-GIEERTEILRLRRRFLKDQEK--LSLIFAKKGVVEQKREKEIKSELKMKHDAQITLY  2779
TASDEVIL            TK-GIDERAEILRLRRRFLKDQEK--LSLIYARKGVVEQKREKEMKNELKMKHDAQVTLY  2783
HUMAN               VK-GAAGRTDLLRLRRRFMRDQEK--LSLMYARKGVAEQKREKEIKSELKMKQDAQVVLY  2772
MOUSE               VKSGTPSQADILRLRRRFLKDREK--LSLLYAKRGLMEQKLEKDIKSEFKMKQDAQVVLY  2773
CRASSO2             RSRNEDQDSEMYRLKRRFLRDEEQ--TKTYFIKRHTRLEKMREEALREQKSRREHQVTMY  2759
POMACEA             NDNNTPDEDNVWKLRRRFLKDRST--ASKYFARREIKEKSKREERLKQQRLRRENQVTLY  2769
TRICHOPLAX          -QSVSQPSSSLNHLRRRYIKSEMA--NNAFYAKRERRKKQLREEILKQQKIARENKVVMY  2769
NEMATOSTELLA        TPAMGSQQQEILRLKRRFTKDSQT-KDRQYFIRMHEKKRQMLQQTQSRLKAARESQVVMY  2769
PRIAPULA            EASAAGGGDDVMRLRRRFLKDQEQ--TRVFFARREARRKQRREEAETLSRQRREGQVXMY  2806
SOFTCORAL           SNENSSQLQNIRKLKRRFVKDRKE--TDVYFAKKEIARQKLRTESVQRQKVARENKVVMY  2786
PISTILLATA          QSQDPNEKKEILKLKRRFLKDQSQ--ISAFFAKQALKRNKFREQALQRQKAAREGAIVMY  2814
HEMICHOR            TEDTSQTDREIMRLKRRFLKDQEA--SRAFFARREIRLKKMREEAQKEQKLRRHNMVTLY  2807
BELCHER             RAAEDSQQSEIMRLKRRFLKDQDV--TKAYHARRQIRMQKMREERVKEQRAKRGNLVTLY  2815
STRONG              RKAPSEGEKEVQRLKRRFMKDQSS--QSAFFAKRATRQKELREEVQKSQRERRFAQVTMY  2812
STARFISH            DAKQSGEDKKINRLKRRFLKDHSS--SQAYFARREMKRKQLKEKILEEQRERKFSTVTMY  2830
                                 *  *                                        : ::
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Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                RYG70450.1
ARCHAEON          AEYRVGEAPDIAISAANLIKPLQTLCLYNPAASSQLLCLLLVSQYRSVDLVKEGIELIDC  3125
MUDCRAB           RQYRVGELPDIQIPHRALIAPLQALSQRDNKVAQLLFDVVVQAVVDNADSLMTRGEKDTW  2799
SCORPION          RQYRIGDLPDIEINYSSIIVPLQALAQHDDEICRMLFQSLILSVCCYMKSNQ-VTEYSEF  2821
SPONGE            RKYRMGELPDIQIKHSELIRPLQALAQNDSGLARLLFCSLFNSIFSQLDHLLTEEDAAAT  2854
CAPITELLA         RQYRTGDFPDIQIKYSFLIAPLQALAQRDSTIAKLLFVAVFQAIFTQIESEKTERESQSL  2819
DANIO             RSYRVGDLPDIQIQFSSLIAPLQALAQRDATLAKQLFSSLFAGVLVEMERLKSNKETADI  2841
MILII             RSYRFGDLPDIQIKYSSLIAPLQALAQKDHSLAKQLFSALFSGILEEVHKSKTA-ETKDI  2848
BAMBOO            RCYRVGDLPDIQIKFSSLIAPLQAVAQKDHSLAKQLFSSLFSGILEEVRKSKTAAEMSGI  2841
XENOPUS           RNYRQGELPDIQISYSNLIAPLQALAQRDPTMAKLLFSSLFSGILTDTAS------DISV  2851
STERLET           RSYRQGDLPDIQIQHSSLIAPLQALAQRDPTLAKQLFSSLFSGILIEMEKSKSQSEKKRI  2858
GAR               RRYRHGDLPDIQIPYSSLIVPLQALAQRDSTLAKQLLSTLFCGILAQMEGSKNEAEKRRI  2855
LATIMERIA         RRYRQGDLPDIQIHYSSLIAPLQALAQRDPTLAKQLFSNLFTGILTEMEKSRSDSERKTI  2849
CAECIL            RSYRHGDLPDIQIAYSNLIAPLQAVAQRDPTLAKQLFSSLFFGIMKEMDKLKSSSEMKDI  2851
SNAKE             RKYRQGDLPDIQIEYSSLITPLQAVAQKDPTLAKQLFSSLFSGILEQMKKSKPLAERNNI  2836
CANARY            RSYRVGDLPDIQIEYCSLIAPLQGLAQKDPTFAKQLFSSLFSGIFHEVKKSKHPSEKNAI  2840
OSTRICH           RSYRVGDLPDIQIEYSSLIAPLQGLAQKDATFAKQLFSSLFTGILREVEKSKTPSEKKII  2810
GECKO             RRYRQGDLPDIQIEYSSLITPLQGLAQRDSTLAKVLFSSLFAGILEEMRKSKSQSEKNSI  2849
TURTLE            RSYRQGDLPDIQIEYSSLITPLQGVAQRDPPLAKQLFSSLFTGILKEMNKFKNPSEKNCI  2849
ALLIGATOR         RSYRQGDLPDIQIEYSSLITPLQGVAQRDPTLAKQLFSSLFTGILKEMENSKSPLEKTHI  2807
PLATYPUS          RSYRQGDLPDIQIEHSSLITPLQAVAQRDPTLAKQLFSSLFAGILKEIDKFKSQSEKRNI  2839
TASDEVIL          RSYRQGDLPDIQIEYSSLINPLQAVAQRDPVLAKQLFGSLFAGILKEMDKFKSPSEKKSI  2843
HUMAN             RSYRHGDLPDIQIKHSSLITPLQAVAQRDPIIAKQLFSSLFSGILKEMDKFKTLSEKNNI  2832
MOUSE             RSYRHGDLPDIQIQHSGLITPLQAVAQKDPIIAKQLFSSLFSGILKEMNKFKTTSEKNII  2833
CRASSO2           RKYRKGDLPDIQIKYSYIIAPLQAVAHRDSSVAKLLFGAIFKGIFSKMDEVKTEREVQET  2819
POMACEA           RRYRIGDLPDIQIKYSYIIAPLQALAHRDNTIAKLLFGAVFKAIYQEMDKVKTDQEMEET  2829
TRICHOPLAX        RKYRDGELPDIQIKHSELIAPFQALAQVCYLDQNYRY---VNLSVNDLVENFNDEDAAET  2826
NEMATOSTELLA      RRYRAGDLPDVQIKHSELIAPLQAVAQCDSTLAKQLFSVLVQAILSQMDEKLTEQDAEKT  2829
PRIAPULA          RKYRIGDXPDVQIQFCHLISPLQALAQRDARVAQLLFSSLCDGVVRRAGDTATERDVDAT  2866
SOFTCORAL         RKYREGDLPDIQIKHSDLITPLQALAQCDSYIAKQLFSGIFRGIFSQIDENVTDTQADEI  2846
PISTILLATA         RKYRSGDLPDIQIKYSELIAPLQALAQCDNTFAKQLFSALFRGIFSKIDEKLPEREAASV  2874
HEMICHOR          RSYRQGDLPDIQIKHMYLIAPLQALAQRDTAIARQLFSSLFCGVFAQIAEEKTERESEEI  2867
BELCHER           RQYRVGDLPDIQIKYSYIIAPLQALAQRDSMLARLLFSSLFRGIFEEIENVKTEREAEDL  2875
STRONG            RQYRTGDLPDIQIKHSDIIAPLQALALRDSTLSRLLFSALFRGILARIGDMCTDGETELH  2872
STARFISH          RRYRTGDLPDIQIKYSDLIAPLQALAQRDASLARLLFSSLFRGIFSEIEEVKTEREAEST  2890
                    ** *: **: *    :* *:* :.
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                RYG70450.1
ARCHAEON          LCDILKQCQSC-SPTCILIPTILQVFIELSSCQPEFVKVLHAKLPDATVCQIALSCGCFH  3184
MUDCRAB           IQQLHSSVNVIIANSYMCHPDMLRTVLHLVINND--IL-----VSPDALAAACLGGHLEA  2852
SCORPION          CRSLSSALNEILKKSVHYHPQLVAFCYECLNCDVKEMD-----IDYEQICTASQASHKQS  2876
SPONGE            KGVIEGNINTILDCSTQYYPPFIGSLQDICYYEN-SLK-----IKPPSITTSSLASKQEF  2908
CAPITELLA         VAKIESSLNKILETSTQYFSPFIGCVLEIAYLFPKQLK-----LQPGVVSTVCNMSDQQP  2874
DANIO             LKELVQTLNAFLNKSTVYFPPFISCIQDMSYHHKALLG-----VEPSLVSATCLASLQQP  2896
MILII             SKQLVENFNYLLKATTLNFPPFVACIQDMSCQHKDLLG-----LDSTSVRSTSLASLQQP  2903
BAMBOO            GKELLKHFTFLLNTTTLCFPPFVTCIQDMSCKHPDLLN-----LDPSIVSSTALVSLQQP  2896
XENOPUS           TDKLLKQFNSFLSNSLSYFPPFIACVQDMCYQHDELLH-----LNPANISTSCLASLQQP  2906
STERLET           TEEILGDMNNFLSKTTVYFPPFVTCVQDMSYRHKELLN-----IEPSSVSSSCLASLQQP  2913
GAR               TEELLQDMNHFLNKSTLYFPPFVTCVQDMSYQYKELLK-----VDPSAVSSSCLASLQQP  2910
LATIMERIA         LLELLGNFNGFLSNTTVYFPPFVTCIQDMSYQHAELLN-----LDPASVSASCLASLQQP  2904
CAECIL            TQKLLADFNRFLNITTSYFPPFVACIQDMSYHHTELLN-----LDPSNVSTSCLASLQQP  2906
SNAKE             IQQLLHDFNHFLTTSVLYFPPFIACILEMTYLHEELLD-----LNCYSVSTSCLASLQQP  2891
CANARY            VQKLLNDFNNFLSMSLSYFPPFIACIQEMSYQHRELLE-----LDSANVSTSCLASLQQP  2895
OSTRICH           IQQLLKDFNQFLSMSMSYFPPFIACIQEMSYQHRELLE-----LDSANVSTSCLASLQQP  2865
GECKO             IQQLVQDFNCFLTTSVLYFPPFIACVQEMSYQHKELLD-----LNPSSVSTSCLASLQQS  2904
TURTLE            TQELLQNFNRFLSMTVSYFPPFIACIQEMSYQHRELLD-----LDSATVSTSCLASLQQP  2904
ALLIGATOR         VQKLLQNFNDFLSISVSYFPPFISCIQEMSYQHKELLD-----IDSTSVSTSCLASLQQP  2862
PLATYPUS          TLKLLQDFNHFLSSTVSFFPPFISCIQEMSFQHTELLN-----LDANCVSTSCLASLQQP  2894
TASDEVIL          TEKLLLDFNYFLSSTMLFFPPFISCIQEMSYQHSELLS-----LDSTTVSTSCLVSLQQP  2898
HUMAN             TQKLLQDFNRFLNTTFSFFPPFVSCIQDISCQHAALLS-----LDPAAVSAGCLASLQQP  2887
MOUSE             TQNLLQDFNRFLNTTFLFFPPFVSCIQEISCQHPDFLT-----LDPASVRVGCLASLQQP  2888
CRASSO2           IQQIQKSIGVVLTTSIQYFTPFISCLLDVLYSLRSKLK-----VDVSDVSSAAMFGNIQP  2874
POMACEA           KEKISDSLGRMLSTSIHYFTPFMGCVMDILHTLRSSLK-----VEVSELSIAAKISNLQP  2884
TRICHOPLAX        KAEIKASLSNIVKKSKHYFPPLIACVQDICYQQK-ELS-----IQSSFASVASLASSQQP  2880
NEMATOSTELLA      VTDIQGALDNIMTSSTQFYPPFISCIEDICYHKS-MLK-----VQPSSVSTASLASLQQP  2883
PRIAPULA          MEKLSEAVSVMASSSTSYFSPFIGCLLDVCYRNISILR-----LDPAVVTTVSQTSMQQN  2921
SOFTCORAL         FRDIQDALNNMITSSTQYFPPFISCIQNVCYNEG-KLS-----LEAGKVTTASIGSLQQP  2900
PISTILLATA        TSDLRSAMNHMLSSSTQFFPPFISSIQDICFHECKLRS-----VDSASVSTACLTSLQQP  2929
HEMICHOR          IKNINEHLNSMLSNSTQYFSPFIGCIEDIAYHNCKELM-----LDAQGISTASLISQQQP  2922
BELCHER           TEQISRFLNTALSNSEKYFPPFISSLQEICYREPRKLS-----PDASVIQQTGVISLQQP  2930
STRONG            VKGIERHLNQMLTDSNQFDPAFISCMLEIGFYHSEQLT-----LDPAAISQSCLTSRQLL  2927
STARFISH          KVEINRHLNTMLSTSTQYFPPFISCVQEISYYHSEQLT-----LVPSTISTASLTSQQMH  2945
                     :          :      ::     .
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                  RYG70450.1
ARCHAEON          IGIRYLEAKLNIIKNSTFAAGKALSAVSQDTAKSTGHSAKRRKGASSSAGIGNRSDTIDE  3244
MUDCRAB           LGVLVLERQVLLSQKG-------------LGRDLPPPQKKLKT----------------  2882
SCORPION          LGILLLEDHLICYN-----------------NFKSSNPAKRIKL---N------------  2904
SPONGE            TGIMLLEKQLLLNV-----------------DS--SKSAKRSRT----------------  2933
CAPITELLA         LGILLLEEGLLHSP-----------------ED-QSPASKRSRR---DR-----------  2902
DANIO             MGILLLEESLLHGA-----------------GASEEPPLKRARG---KR-----------  2925
MILII             MGILLLEKSLIHST-----------------TN-EEPPTKKARG---RQ-----------  2931
BAMBOO            MGIMLLELSLMHLS-----------------LP-EEPPAKRSRG---RT-----------  2924
XENOPUS           LGILLLEKGLLHMK-----------------VP-DEPPAKKMRKEKEKA-----------  2937
STERLET           MGILLMEESLIKGL-----------------VP-EEPPAKRARG---RR-----------  2941
GAR               MGILLLEESLIRGS-----------------VP-DEPPSKRARG---HR-----------  2938
LATIMERIA         MGVLLLEQGLIQLL-----------------AA-EEPPAKRARG---RK-----------  2932
CAECIL            VGILLLERSLMSLV-----------------DT-EEPPRKKMRG---KT-----------  2934
SNAKE             MGILLLEQALVHLF-----------------PVEQQPPSKRMRG---KT-----------  2920
CANARY            MGILLLERALMALS-----------------PA-EEPPSKRMRG---RT-----------  2923
OSTRICH           VGILLLEHALISLS-----------------PA-EEPPSKRVCG---RA-----------  2893
GECKO             VGILLLEQALVHLS-----------------SEEEEPPAKRMRG---KT-----------  2933
TURTLE            VGILLLEQALTRLS-----------------SE-EEPLSKRMRG---RA-----------  2932
ALLIGATOR         VGILLLEQALIHLS-----------------TI-EEPPAKRMCG---RT-----------  2890
PLATYPUS          VGILLLEQALIRLG-----------------PP-EEPSSKKRRG---KP-----------  2922
TASDEVIL          VGILLLEKALIHLT-----------------PA-EEPPSKRMRG---KP-----------  2926
HUMAN             VGIRLLEEALLRLL-----------------PA--ELPAKRVRG---KA-----------  2914
MOUSE             GGIRLLEEALLRLM-----------------PK--EPPTKRVRG---KT-----------  2915
CRASSO2           LGICVLEEQLISQD-----------------E--DERPSKRGRS---D------------  2900
POMACEA           LGIEVIEERLITED-----------------SG-GARPSKRSRY---D------------  2911
TRICHOPLAX        IGILLLEKQIMHLD-----------------T--EEPPSKRIKT----------------  2905
NEMATOSTELLA      MGILLLEKQLLSQE-----------------A--EPKSHKRMRT---E------------  2909
PRIAPULA          LGIVLLEKMLMQGA-----------------CDDESRPAKRMRA---GS-----------  2950
SOFTCORAL         TGIMLLEKQILQMA-----------------EDPGERPRKRQKT---G------------  2928
PISTILLATA        IGIMLLEKQLLEIE-----------------GK-SQNSRKRAKT---S------------  2956
HEMICHOR          LGLLLLEEYLVQKS-----------------GE-EERSRKRPRG---S------------  2949
BELCHER           IGIVLLEEQLVQKA-----------------GV-EEPRSKRART---S------------  2957
STRONG            IGIRVLEEVLIKKS-----------------GD-DERSRKRART---S------------  2954
STARFISH          IGIRLLEENLIQKP-----------------WQ-EEKSAKRARF---V------------  2972
                   *:  :*  :                          *:
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                RYG70450.1
ARCHAEON          LFAQIETSTGDPAAAKNTVVTFDDVDSSSIFIQLMHLYDRLSEENIVNTLAEAVFLNDRS  3304
MUDCRAB           --------------------HLNSQLDTSTWINMAELYKNLSMWDVVRGIIHSKL----G  2918
SCORPION          --------------------KPLISDELSIWLKMAEIYKSLSDYDSVHGIFSNSL----N  2940
SPONGE            ----------------------NKSNEVTETWIELARLYKSLEDYDVLHGIFTNLD----D  2968
CAPITELLA         --------------------SSRITQDTEPWLELAKLYKSISDYDVLRGIFSSQI----G  2938
DANIO             --------------------ELPPDT--ERWIHLAKLYRSLGDYDVVRGIFSGKI----G  2959
MILII             --------------------ELPPDTDVARWIELATLYRSLGDYDVLRGIFSEKI----G  2967
BAMBOO            --------------------QLPPDT--ARWVELAKLYRSLGDYDVLRGIFSEKI----G  2958
XENOPUS           --------------------EIPPDI--VRWIELAKLYRSIGDYDVLRGIFSGKI----G  2971
STERLET           --------------------ELPPDT--ARWIHLAKLYRSLGDYDVLRGIFSGKI----G  2975
GAR               --------------------ELPPDT--ERWIHLAKLYRSLGDYDVLRGIFSGKI----G  2972
LATIMERIA         --------------------ELPPDT--IRWLELAKLYRSLGDYDVLRGIFSGMI----G  2966
CAECIL            --------------------ELSPDV--VRWIELAKLYRSLGDYDVLRGIFSGKI----G  2968
SNAKE             --------------------ELSPDV--TRWIELARLYRSVGDYDVLRGIFSGKI----G  2954
CANARY            --------------------ELPPDV--IRWIELAKLYRSLGDYDALRGIFSGKI----G  2957
OSTRICH           --------------------ELPPDV--IRWIELAKLYRSLGDSDVLRGIFSGKI----G  2927
GECKO             --------------------DLSPDV--IRWIELAKLYRSVGDYDVLRGIFSGRI----G  2967
TURTLE            --------------------ALSPDV--IRWIELAKLYRSVGDYDVLRGIFSGKI----G  2966
ALLIGATOR         --------------------ELSPDV--IRWIELAKLYRSVGDYDVLRGIFSGRI----G  2924
PLATYPUS          --------------------QLPPDV--VRWIELAKLYRSVGEYDVLRGIFSGEI----G  2956
TASDEVIL          --------------------QLSPDV--IKWIELAKLYRSIGEYDVLRGIFSGEI----K  2960
HUMAN             --------------------RLPPDV--LRWVELAKLYRSIGEYDVLRGIFTSEI----G  2948
MOUSE             --------------------CLPPDV--LRWMELAKLYRSIGEYDVLRGIFSSEL----G  2949
CRASSO2           --------------------NAVVSTDTLSWIELARLYKSVKEYDVLLGIFSGRI----G  2936
POMACEA           --------------------VTPVTKDDMQWIELAKLYKSLGEFDVLHGIFSGML----K  2947
TRICHOPLAX        ---------------------SSASEATSNWIELSKLYKSIGYYDVLRGIFSGHL----G  2940
NEMATOSTELLA      --------------------HSPSSDTTAAWLELAKLYRSVEEFDVLHGIFSDHI----G  2945
PRIAPULA          --------------------GMGVSQHTDTWIELARLYKSLGDYDTLHGIFNDKI----G  2986
SOFTCORAL         --------------------GNPSPESTATWIELSKLYKSVEDFDVLQGIFNSHI----G  2964
PISTILLATA        --------------------TVPPSEVTTCWIELSKLYRSVGDYDVLRGIFTGHI----G  2992
HEMICHOR          --------------------ASLLSQEISTWIELSRLYKDLDNFDVLRGIFSGKV----G  2985
BELCHER           --------------------SSPVSAETATWIELARLYKSLGDFDVLQGIFSRKV----G  2993
STRONG            --------------------RPESNQEMSTWIELARLYKAMGEFDVLRGIFGALI----K  2990
STARFISH          --------------------SREPSPEISTWIELARLYKALGDFDAVQGVFSACI----G  3008
                                        ::.:  :*  :   : :  :
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                RYG70450.1
ARCHAEON          SDEAAAQMKEAIDYEARGEFTSAVEVYNSLLRGI-GSNSGSQLTGPCKKRNFAASQLDAS  3363
MUDCRAB           R--IKPETREALEAEATNDSVQAFIIYRTALNT--QWPE--EP----------------  2955
SCORPION          I---QEETKQALEFESRGEYLLAVKIYSKLYDQT-EWSAE-EP----------------  2978
SPONGE            T---KDVTRKALEAEERGDYLTALNLYKKAIDF--DWPQGESP----------------  3006
CAPITELLA         S---KPATRLAIEAETRGDYRSALQLYNESLAKE-EWDDGEHP----------------  2977
DANIO             T---KSITFTALQAEAKSDYAEAVKLYNEALNKE-DWDDG-EP----------------  2997
MILII             T---KPLTHTALLAEAKSDYAEAVRLYDQALNTE-EWMDG-NP----------------  3005
BAMBOO            T---KSTTQKALLAEAKSDYAEAVQLYDQALNTE-EWVDG-NP----------------  2996
XENOPUS           A---KSITQCALNAEAKSDYAKAAKLYDEALT-E-TFSDG-DP----------------  3008
STERLET           A---KSITSMALQAEAKSDYAEAVKLYNEALNTE-EWTDG-EP----------------  3013
GAR               A---KPVTSLALQAEAKNDYSQAVKLYNEALNTE-EWMDE-GP----------------  3010
LATIMERIA         T---KQVTQKALLAEAKSDYSEAVRLYDEALNVE-EWPDG-EP----------------  3004
CAECIL            T---KPHTKDALLAEAKSDYATAAKLYDEALNMP-DWSND-EP----------------  3006
SNAKE             T---NEITHNALLAEAKSDYAEAAKLYDKALSIQ-DWPGD-EP----------------  2992
CANARY            T---KEITQKALLAEARNDYAEAAQYYDKALSQE-DWQDG-EP----------------  2995
OSTRICH           T---KEITQKALLAEARSDYATAAKHYDEALSKE-DWQDG-EP----------------  2965
GECKO             T---KEVTQKALLAEANSDYAEAAKQYDEALSKQ-DWPDE-EP----------------  3005
TURTLE            T---KEITQNALLAEARSDYAEAAKQYDEALSKQ-DWPDG-EP----------------  3004
ALLIGATOR         T---KEITQKALLAEAKSDYVEAVKQYDEALSKQ-DWSDG-EP----------------  2962
PLATYPUS          T---KHVTQIALLAESKSDYSEAAKQYNEALNMQ-HWEDG-EP----------------  2994
TASDEVIL          T---KPVTQNALLAEAKNDYSEAAKQYNEALNTQ-EWLEG-DP----------------  2998
HUMAN             T---KQITQSALLAEARSDYSEAAKQYDEALNKQ-DWVDG-EP----------------  2986
MOUSE             T---TQDTQNALLAEARSDYCQAAKLYDEALNKL-EWVDG-EP----------------  2987
CRASSO2           T---QDITKEAVQMEARGDYYKAVKLYNQALSCN-DWDE--NP----------------  2973
POMACEA           T---KEVTQLALIEESHSEYKAAIALYNKALESA-DHDP--RP----------------  2984
TRICHOPLAX        T---KDITQRALEAESRHDYAAAVKYYNQAMDCS-SWPDG-EP----------------  2978
NEMATOSTELLA      T---KPITRLALEAEARGDYAQALKIYNEAMSCD-DWSS--KP----------------  2982
PRIAPULA          T---QTCTQEALQAEASCDYKLARKLYQRALE-M-EWGESEGP----------------  3024
SOFTCORAL         T---QSITKDALEAEGRGDYTEALKLYSQATNCD-EWPAGSSP----------------  3003
PISTILLATA        T---KDITREAMEAEARGDYSQALKLYNEAIGTDDVWIKE-EL----------------  3031
HEMICHOR          T---QPVTREALEAEASANYQKAANLYDEALGCT-DWPDG-RP----------------  3023
BELCHER           T---QTVTYEALEAEARGDFKKAVELYNQAMQET-EWPDP-QP----------------  3031
STRONG            T---KDVTQEAIQAESRGDYESALELYSKAIS-S-DWGPD-GV----------------  3027
STARFISH          T---HEITKTALEAEARGDYSTALKLYNQAFE-M-DWDEG-AV----------------  3045
                             *:  *   :   *   *
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                RYG70450.1
ARCHAEON          SLGQGQVLGLLVGRSLECYHKLASWESLYSCTAY-LFEG-SGVVDRMDLDGESAQRVLSD  3421
MUDCRAB           ---DPAEVHLWEECYASCAAKLGQWSELENFVENRLLKDEAGQVSLN--------QVWTL  3004
SCORPION          ---NQAEIDLWDNAILQCYDYLTQWDLLQLSIIN-RLDENQKQPNLN--------KIWEE  3026
SPONGE            ---PQVEEDLWEDSLLNAYSHLTKWKDLEKASTC-NIGE-ETNSKLE--------QLWKD  3053
CAPITELLA         ---TEAEINMWDSSRIECAENLTQWRDVETLSTS-DLE----GSSLS--------AVWDS  3021
DANIO             ---TITEKDFWEIAALEAYNHLTEWKSLEYCATV-NIDD-SSPIRLD--------RMWTE  3044
MILII             ---METEKDFWEIAALECYNHLTEWKALEYCSTV-NIDD-KTPADIE--------NIWSD  3052
BAMBOO            ---TDAEKDFWDIAALECYSHLTEWKSLEYCSTV-NISD-KTPVDLE--------DIWTD  3043
XENOPUS           ---TDAEKDFWELASLECYNHLTEWKPLEYCSTV-NIDT-GKPPDLN--------KMWSD  3055
STERLET           ---AEAEKDLWEIAALESYSHLTEWKSLQYCSTV-NIDD-SSPADLE--------KIWGD  3060
GAR               ---TDTEKDFWEIAALECYNHLSEWKSLQYCATV-NIGD-SSPVDLE--------KMWSD  3057
LATIMERIA         ---TEAEKDFWELAALECYSHLTEWKALEYCSTV-NIDD-KTPADLE--------NIWND  3051
CAECIL            ---TEAEKDFWEVAALECYNRLTEWKPLEYCSTV-NIDD-SKPADLN--------KIWND  3053
SNAKE             ---TEAEKDFWKIASLECYNHLTEWKSLEYRLTV-NIDN-GQPADLN--------KIWSD  3039
CANARY            ---TEAEKDFWELASLECYDHLTMWKSLEYCATV-NIDS-GKPPDLS--------KTWND  3042
OSTRICH           ---TEAEKDFWELASLECYDHLTEWKSLEYCATV-NIDS-GQPPDLN--------KTWND  3012
GECKO             ---IEAEKDFWEFASLECYDHLTEWKSLEYCSTV-NIDD-KQPPDLN--------KTWSN  3052
TURTLE            ---TEAEKDFWELASLECYNHLTEWKSLEYCSTV-NIDS-GQPPDLN--------KTWSD  3051
ALLIGATOR         ---SEAERDFWELASLECYDHLTEWKSLEYCSTL-NIDS-EQPADLN--------KTWSD  3009
PLATYPUS          ---SEAEKDFWELAVLECYNHLTEWKSLEYCSTV-NIDS-ESPPDLN--------KIWND  3041
TASDEVIL          ---TEAEKDFWELAALECYNHLTEWKSLEYCSTI-NVDS-ENPPDLS--------KMWSE  3045
HUMAN             ---TEAEKDFWELASLDCYNHLAEWKSLEYCSTA-SIDS-ENPPDLN--------KIWSE  3033
MOUSE             ---TEAEKEFWELASLDCYNNLSKWKELEYCSTV-NIVS-ENSLDLS--------KMWSE  3034
CRASSO2           ---PTIEVDMWDESRMECLDNLSQWKELEGVAMS-GIS----SNSIS--------QVWKD  3017
POMACEA           ---LEAEIDLWDESRMECLNRLTEWTKLEMVTTD-ALSQ-EGEISLA--------SVWDD  3031
TRICHOPLAX        ---QAEEEDLWEISRLECLYNLTQWDKLEYLSLV-NVD-NNDPPSFD--------KIWED  3025
NEMATOSTELLA      ---QQQEEDLWDDARMQCFANLAKWGDLEEYSKT-GVDDEGNPPDLD--------KIWTD  3030
PRIAPULA          ---GQGERDLWDISLMQCLDRLTDWTALDAHTKECLIPEGSSEADLQ--------LLWED  3073
SOFTCORAL         ---LQAEEDFWDDSILECCRRLTLWDKMDHNCIV-NFDEANGVLDLN--------QIWRD  3051
PISTILLATA        ---RQEEEDLWDVSRLQCLADLTKWKELEKCSVE-SIDD-KNPPDLD--------KVWSD  3078
HEMICHOR          ---EQVEEDLWDDCRLQCYEQLTDWQKLEQASTI-NIDD-NDPPDLD--------KIWDD  3070
BELCHER           ---LAVEEDLWDDSRLQCYDHLTQWKNLYEVSTV-NIDE-DSPPNLD--------KMWDD  3078
STRONG            ---AREEEDFWDEARLQCCNQLTKWDDMESFSTD-QIEG-KGSNDLS--------QIWND  3074
STARFISH          ---SQVEEDLWDESRLNCCNQLTQWKELQNYSTV-NIDD-NSPHDLG--------KIWSD  3092
                             :      ..   *  *  :         .
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                RYG70450.1
ARCHAEON          FVLNQSLADEDRAAHLRRTAASYYLRSFIHLSFPLLEKPLAMQSRAFLATQLIALK----  3477
MUDCRAB           P-----R--------PAVSVLPSIVNSKLMS----ILDGSE-TDRNLNAFIDSALGEPNH  3046
SCORPION          P-----Y--------YQENYLPFLIKSKLKL----LIENR--NDQSLLCFIDSALKEENK  3067
SPONGE            S-----Y--------CQEHYLPFVLSSKLKL----WCTDD--SDHGLASFLDKSLSEEAN  3094
CAPITELLA         T-----Y--------HQEVYLPPMLRSKIKL----ILNGDT-SQDNLLSFIEESLKTPVH  3063
DANIO             T-----F--------YVETYLQYMMRSMLKQ----LQMGE--TNQDLLSFVDAAMKTEEH  3085
MILII             T-----F--------YQETYLSYMIRSKVKL----LQSGE--VDQSLLTFVDRAMKVEQR  3093
BAMBOO            P-----F--------YMEAYLPHMMRSKVKL----LQLGE--NDQSLLTFVDNAMKVDQR  3084
XENOPUS           P-----F--------YQETYLPYMIRSKLKM----LLGGN--NDQTLLTFVDEAMKVEQR  3096
STERLET           P-----F--------YQEAYLPYVMRSSVKL----LQLGE--PDQSLLTFVDNAMKVEER  3101
GAR               P-----F--------YQEAYLPYVVRGMVKQ----LQLGG--QDQSLLTFVDNAMKVEER  3098
LATIMERIA         P-----F--------YQETYLPYLMRSKVKL----LLLGQ--GDQSLLTFIDNAMKVEER  3092
CAECIL            P-----F--------YQETYLPYMIRSKVKL----LLQGK--DDQSLLTFIDNAMKVEQR  3094
SNAKE             P-----F--------YQEAYLPYVIRSKLKL----LFHGG--SDQSLLTFIDEAMKAEEK  3080
CANARY            P-----F--------FQETYLPYIIRSKLKL----LLSGE--NDQTLLTFIDEAMKTEQK  3083
OSTRICH           P-----Y--------YQETYLPYIIRSKLKL----LLNGE--NDQTLLTFIDEAMKTEQK  3053
GECKO             P-----F--------YQETYLPYIIRSKLKL----LLHGG--DDQSLLTFIDEAMKTEQK  3093
TURTLE            P-----F--------YQETYLPYIIRSKLKL----LLHGG--NDQSLLTFIDEAMKIEQR  3092
ALLIGATOR         P-----F--------FQETYLPYIIRSKLKL----LLHGG--SDQSLLTFIDEAMKIEQR  3050
PLATYPUS          P-----F--------YQETYLPYMIRGKLKL----LLQGG--SDQSLLTFMDEAMKKEKQ  3082
TASDEVIL          P-----F--------YQETYLPYMIRSKLKL----LLQGA--SDQSLLTFIDEAMKKEPQ  3086
HUMAN             P-----F--------YQETYLPYMIRSKLKL----LLQGE--ADQSLLTFIDKAMHGELQ  3074
MOUSE             P-----F--------YQETYLPYVIRSKLKL----LLQGE--GNQSLLTFVDEAMNKELQ  3075
CRASSO2           T-----Y--------YQEHYLPYIIRSKVKL----MLQGDG-DQQPLLTFIDDCMKQTEQ  3059
POMACEA           T-----Y--------YMETYLPYLIRSKLKL----LLHGDE-KQQSLLSFIDDSMKNPQH  3073
TRICHOPLAX        N-----Y--------YQENYLPLFLKSKAKV----MCENDLAGSDDFIQYLNKSLANDEH  3068
NEMATOSTELLA      T-----Y--------LQEHYLPFIMRSSIKL----ICEGEE--RPCFLEFLRHSMMNEER  3071
PRIAPULA          T-----Y--------YEENHLPFVMRARLKR----LLVEG-ARDQTLLSFVDAATGHPDR  3115
SOFTCORAL         D-----Y--------YKEHYLPFLLCSKTKK----FCIGD--RDEVFFNFIFDSLKNEER  3092
PISTILLATA        T-----F--------YQEHYLPHLITSKLKL----QCQGS--GDMTLNEFVAKAMKTSER  3119
HEMICHOR          T-----Y--------YQEHYLPYVIKSKLKL----LMEDDDTDDQSLLTFIDKSMQHKER  3113
BELCHER           T-----Y--------FQEHYLPFTIRSKLKL----LLEGE--MDQSLLNFVDSAMQKPDR  3119
STRONG            D-----Y--------QQEIYLPYMMRSKLKR----LMEGS--EDDSLLGFIDSSAKDQEK  3115
STARFISH          T-----F--------YQELYLPHMMRSMLKQ----LMEGG--EDETLLQFIDASMSDADK  3133
                                        : .                   :       .
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Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

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                                                                                                  RYG70450.1
ARCHAEON            SNHSASLSSLDLAASHILLEDYYQASLAMKDAVSTFLNKFTMLHAVAYKG--KAGLLLSL  3535
MUDCRAB             RNLLESTLPLPLAIMSAHQQKMAQARHYITLATSKVLLTLAQSSLLTPKP--LTGTVRDI  3104
SCORPION            KKYLEENFSEELALLYIIQENYDRAQYYSQLCLQDFLKEWSSLNVLMPII--RKTKLQSL  3125
SPONGE              RSVLESHYPQELTLSYVLRDDYDRAYYYLSLSLKAKQQIWSVQDGISSSTGAVSSTVQSL  3154
CAPITELLA           KAFIEGSFSSELALVCIHQELYDKAKHYANMSLQAFIQDWANLSTTRTST--RATKLQKL  3121
DANIO               KIIMETHYSQELSLLYILQEDYDRAKYYANNCMQVFMQNYSSIDPLLNRS--RLTVLQSV  3143
MILII               KAVIETYYSQELSLLYILQDDVDRAKYYINNCMEVFMQNYSSIDTLLHQS--RLTKLQSL  3151
BAMBOO              KTVIETRYSQELSLLYILQDDFDRAKYYVNNSIQSFMQNYSSIDPLLHRS--RLTKLQSL  3142
XENOPUS             KVLMETFYSQELSLLYILQDDFDRAKYYINNGIQVFMQNYSSIDCLLYQS--RLTKLQSV  3154
STERLET             KSIIETSYSQELSLLYILQGDFDRAKYYVNNCMQVFMQNYSSIDTLLPGS--RLTKLQSV  3159
GAR                 KSVMETNYSQELSLLYILQDDYDRAKFYINNSMQVFIQNYSNIDALLYGS--RLAKLQSV  3156
LATIMERIA           KALLETHYSQELSLLYILQDDFDRAKYYVGNCMQVFMQNYSSIDTLQHKS--RLTKLQSV  3150
CAECIL              KALLETNYNQELSLLYILQDDFDRAKYYIDNGIQVFMQSHSSIDTLLNKS--RLTKLQSV  3152
SNAKE               KALIEMYYSQELSLLYILQDDFDRARYYVKNAMQVFMQNYSNIDSLLFNS--RMIKLQSV  3138
CANARY              KAIIEMHYSQELSLLYILQDDFDRAKYYISNGMQIFMQSYSSIDSLLYQS--RITKLQSV  3141
OSTRICH             KAIIEMRYSQELSLLYILQDDFDRAKYYISNGLQIFMQSYSSTDTLLHQS--RMTKLQSV  3111
GECKO               KALIEMYYSQELSLLYILQDDFDRAKYYISNAMQVFMQNYSSIDSVLHQS--RLTKLQSI  3151
TURTLE              KALIEMYYSQELSLLYILQDDFDRARYYISSGMQAFMQNYSSIDTLLHQS--RLTKLQSV  3150
ALLIGATOR           KALIEMHYSQELSLLYILQDDFDRARYYISNGMQVFMQNYSSIDALLHQS--RLTKLQSV  3108
PLATYPUS            KTLIETHYSQELSLLYILQDDFDRAKYYIDYCIQIFMQNYSNIDALLLQS--RLTKLQSV  3140
TASDEVIL            KTLIEVHYSQELSLLYILQDDFDRAKYYIENSIQVFMQNYSSIDALLHQS--RLTKLQSV  3144
HUMAN               KAILELHYSQELSLLYLLQDDVDRAKYYIQNGIQSFMQNYSSIDVLLHQS--RLTKLQSV  3132
MOUSE               KTVLELQYSQELSLLYILQDDIDRATYYIKNGIQIFMQNYSSIDVLLYRS--RLAKLQSV  3133
CRASSO2             KALIESRYSEELALMYIWQADYDRARHYSTLATQQFLLDWSSTDSLMSVS--RKSQLQRL  3117
POMACEA             RAHLESRYCEDLALMYVWQKNFDLARHYARLAVQSFFQDWSSTDSLMTAS--RTHCLQRL  3131
TRICHOPLAX          LSVLENRHCDCLALIHVLLEKYDRARYYLDFSIQKFLQDWSALDSTLLYS--RASKLQSL  3126
NEMATOSTELLA        KAFLESRYGDDLALLFILRDDYGRARYHVTNCFQAFLKDWSGLSSMMVSS--RASKLQSI  3129
PRIAPULA            RAVIETWHGEELALLYIVQGDYTRARHHAARCLQAFLRDWASLDALMLAS--RAARLRSL  3173
SOFTCORAL           KVYLENKYSDILALLFILDEDYDRARYYTSICLQAFLEDWSGLDSIMTSS--RSAHLQSL  3150
PISTILLATA          AALLRSRYSDSLALMYVLQDNCDSASYYAALSEQSFLSDWAGLDSNLRSS--RSIKLQSL  3177
HEMICHOR            KALIENRYSEALAMLYLLQDDYDRARYYTANCIQSFLQDWSGTDTLMGTI--RSSKLQCV  3171
BELCHER             KALLESRYCEELAMLYLYQDDYGRAKYYVGNCTDAFLQEWSGMDRLMTSS--RAAKLQSL  3177
STRONG              RVILESRYTEELAALSILKEDYNRAKYYLANSTSSFLQEWSGLGPLMLTS--RLSKLQDI  3173
STARFISH            RAFLEARYSEELSTLYTIQEDYDRAMFYLANCRQSFLHDWSGLGPLMISS--RRAKLQCI  3191
                                 *:           *        .      :               :  :
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                RYG70450.1
ARCHAEON          QRMNELRDFIFYNTQ-QAYIASKISAMQGLANSTGQQKKIALNNLEDDIIKAWTLSEPNI  3594
MUDCRAB           QLVTELGEFLETLDY-THNEN--------------------YPNKVRKTVKNWKTQETCL  3143
SCORPION          QKHIELQEFLNFIDT-YRNI---------------------DEYHFKNLTDRWLKRYPDI  3163
SPONGE            QRLTEMNEFITFMKS-NDNFSSP------------------G--PVNNLLRKWRKRFPDP  3193
CAPITELLA         QEFTEMQEFLSVIKTTSG-E--D------------------FPRQIDRTLHKWEARSPDR  3160
DANIO             QALTEIQDFLNYITG-DV---SV------------------N--SLKFMIRRWTSHYPDA  3179
MILII             QAVTEMQDFLHFISK-EYNFISE-------------------V--PLRKLLRTWTGRYPDA  3190
BAMBOO            QTLTEIQDFLHFITK-GSNLTSE-------------------V--PLRKLVRTWIGRYPES  3181
XENOPUS           QALTETQDFISFIRK-PGNVSS--------------------S--SLRKLFQGWMKRYPDS  3192
STERLET           QALTEIQDFLNFMTK-DV---SQ------------------T--SLKSLIRIWTDRYPDA  3195
GAR               QALTEIQDFLYFITK-DV---ST------------------A--SLKTLIRTWTHRYPDD  3192
LATIMERIA         QALTEMQDFLGFISK-PDHLNSR------------------A--SLRRLLRNWSDRYPDA  3189
CAECIL            QALTETKDFIHFISK-PSNLTSQ------------------T--SLKRLLRIWSSRYPDS  3191
SNAKE             QALTEIQDFINFMSK-ESSLTFQ------------------A--SLKRLLNIWRSRYPDT  3177
CANARY            QALTEIQDFINFMTK-RSNLASE------------------A--SLKRLLRTWTSRYPDA  3180
OSTRICH           QTLTEIQDFIHFMTK-TSNLASQ------------------A--SLKRLLRIWTSRYPDA  3150
GECKO             QTLTEIQGFVNFISR-SGNIASQ------------------A--SLKRLISIWMSRYPDS  3190
TURTLE            QALTEIQEFINFISK-PSSLASQ------------------V--SLKRLLRIWRSRYPDD  3189
ALLIGATOR         QALTEIQDFINFMRE-PSNLASQ------------------A--SLKRLLRIWTSRYPDA  3147
PLATYPUS          QALTEIQDFTNFISR-PSNLSSQ------------------A--SLKRLLRIWTNRYPDA  3179
TASDEVIL          QALIEIQDFVNFMSK-QGNLSSQ------------------A--PLKRLLRIWTNRYPDA  3183
HUMAN             QALTEIQEFISFISK-QGNLSSQ------------------V--PLKRLLNTWTNRYPDA  3171
MOUSE             QTLAEIEEFLSFICK-HGDLSSL------------------G--PLRRLLKTWTSRYPDV  3172
CRASSO2           QPLVELQEFLSFMAS-EGNFTSV------------------T--PANSLIERWQARALHP  3156
POMACEA           QPLLELQEFLDFVAD-KNNFTSF------------------E--PSHQLIARWEQRYPHV  3170
TRICHOPLAX        QTLTEMQEFLQFMDD-GRNFESV------------------T--PVLSLISKWSTRFPNE  3165
NEMATOSTELLA      QKITEMQEFLEFVVK-EGKLLK-------------------K--TLEDLFSRWSVRFPNS  3167
PRIAPULA          QKLTEMNEFLDAITATPDAFTRN------------------D--TARALVDRWMDHMPHP  3213
SOFTCORAL         QALTEMQEFLDFISH-EDNFSTI------------------S--SVKSLLKRWSSREPDP  3189
PISTILLATA        QKITEMQEFLEFIAE-EGNF--S------------------SPMPVLSLLNKWYSRLPHP  3216
HEMICHOR          QKLSEMQEFLTFITN-ERNFDEH------------------K--PVSDLISKWTKRLPDV  3210
BELCHER           QKLTEMQEFLELISN-DRNF--E------------------TPWPVTRLLEKWSSRYPDN  3216
STRONG            QKLTEAEQFLQLANK-PFSEGLK------------------S--SATRLVSDWSRNLPDP  3212
STARFISH          QRLTEKQNFLKLAIK-PDLQEAI------------------GCQKSLELLDRWSGCHLDS  3232
                  *   *   *                                              *
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                RYG70450.1
ARCHAEON          -FDPLHHWSDVIWTRSLMLQKLADSNSNQDAQ-------LSAKG-------------AEH  3633
MUDCRAB           -TDSSVLMQFLSSHRELYFQFLEKELPQD-------------------------CLED  3175
SCORPION          -FDSVNIWDDIIMNRSLYMEKIVSKLQETNNQ--STSFSLEESMDTS--IVDSEPNSYFD  3218
SPONGE            KLDPVPIWDDIITTRWMMLRKISTKLQDSVLS-QQCEYLLDDDG------------SSCS  3240
CAPITELLA         LLDSVVIWDNIILNRNVYMDHFAEHLTSIDAK--------------------------  3192
DANIO             KLDPMNVWDDIITSRCFFLDKILKRLKST------PENSMEVDGADQG--------SGEE  3225
MILII             KMDPMSIWDDVITNRCFFLDKIQERLVSV-----QADESMEVDREGEVETRMEVDKEEED  3245
BAMBOO            KLDPMSVWDDVITNRCFFLDKIKERLSLL-----QADDSMEVDDEGA-ETQMDIDKEEDD  3235
XENOPUS           KMDPMNIWDDIISNRCFFLDKIQDVAVGHPQ---LVDESMEVDDLADGNEAMEVDR-QED  3248
STERLET           KMDPMNVWDDIITTRCFFLDKIAGKLTNS-----EADNSMEVDGGEDTGVKMEVDE-PED  3249
GAR               RMDPMNVWDDVITNRCFFLDKISEKLVSS-----VAGDSMEVEEDGDKEIKTEAGE-WED  3246
LATIMERIA         KMDPVNIWDDIITNRCFFLDKIQEHLCKV-----PADESMEVDGEGDASPRMDVDE-EPN  3243
CAECIL            KMDPMNVWDDIITNRCFFLDKIREKLPHF-----QADDSMEVDGGGDASDRMELGGEEED  3246
SNAKE             KMDPMNIWDDIITNRCFFLDKIQEKFSST-----HLDDSMELDGDAT--FSMEIDNENQD  3230
CANARY            KMDPMNIWDDIITNRCFFLDKLQEKLPSD-----QANDSMEVDGEYSAGDQMEVDQQGEN  3235
OSTRICH           KMDPMNIWDDIITNRCFFLDKLQEKLPRD-----QANDSMEVDEKDDIGDQMEADQQGED  3205
GECKO             KMDPMNIWDDIITNRCFFLNKIQERLPNT-----HLEDSMEVDGGGDANDNIEGGNEKED  3245
TURTLE            KMDPMNIWDDIITNRCFFLGKIQEKLPNI-----QADDSMEVDGRGDVGDKMETDMQEED  3244
ALLIGATOR         KMDPMNIWDDIITNRCFFLDKIQEKLLNV-----QADDSMEVVEAGDIGDEMEVDQQEDN  3202
PLATYPUS          KMDPMNIWDDIITNRCFFLSKIQEKLAGL-----QADDSMEMDGGGDTTDRMELEKQEDD  3234
TASDEVIL          KMDPMNIWDDIITNRCFFLNKIQEKLNCL-----QLDDSMEVEGDGHFIDKVEVEKQEED  3238
HUMAN             KMDPMNIWDDIITNRCFFLSKIEEKLTPL-----PEDNSMNVDQDGDPSDRMEVQEQEED  3226
MOUSE             VTDPMHIWDDIITNRCFFLSKIEERLTAP-----SGDHSMSVDEDEESIDR-EVYEPKED  3226
CRASSO2           LLDTEAVWDNVVTNRMVFLDHISNRLSTSLVK--KEEDAMEEDE----------------  3198
POMACEA           QLDLVDIWDDVVTNRNVYMDKIRDQMLSSNLM--EE-----DHD----------------  3207
TRICHOPLAX        VIDPINVWDDVIVNRCMYLRKILLQYRVIQTAFTSTEDSMEIDGEDRVIY------TFPA  3219
NEMATOSTELLA      KLHPISVWDDVITNRRIFGLTVC----------VYRPDSMDVDGEWS-CP------SVDA  3210
PRIAPULA          TLDPVSIWDDTVINRCLYMDHLSRHFHGNQPA-G--------------------------  3246
SOFTCORAL         KLHSVGVWEDVMTNRSVFLDKILLKFGQSSQL-HSSEDSMEIDGLN-----------TTQ  3237
PISTILLATA        ILHPIGVWDDIVTNRVLFMSKFLQKFEAMGAE-ERSGIC----L--------------DD  3257
HEMICHOR          KRDSTNTWDDVITNRVFYLRKLFQKSGDAMEG----D-----DG--------------QA  3247
BELCHER           RMDPISVWDDIIANRCLYLDKLNDKFEQMAAR-GVLD--TEVGG--------------EP  3259
STRONG            KRDPISVWDDVTQYRCLYMDKLCNLLGDSGGG-GGGGDSMETED--------------QK  3257
STARFISH          KKDPINIWDDVVSNRLLYMDKLGSRFIRSESQ-QAGE-----EE--------------TA  3272
                     .     .     * .    .
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

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                                                                                RYG70459.1
ARCHAEON          SGRRAGLTIEEVQVVTFYNRASILEQVEFNKVEELLTKTKKMLDMKDDSLR----KAQAE  3734
MUDCRAB           TNIQRGRS----------------R-PQNRLQYLVEAWVKFLGKVTS------MPVLEQ  3266
SCORPION          IDLKKAKN----------------QNYPEQLDTLL-CAHKQLAKLDL-------HFPKK  3311
SPONGE            VRLDRIHQ----------------DPSPTDMEAVI-SLTCQMDNFKGRLGGSGKGAIS-  3341
CAPITELLA         ANKRKCAS----------------GSEPSERLNLLV-EVKKRLDKCSE------SSTLKL  3286
DANIO             FTHKRIAR----------------LGPSEKINALL-KTVPLLK-DAE------RQSEAL  3316
MILII             LSHRRSQR----------------QARPEQVVTVL-KSIPLLV-EIN------VDYLNT  3336
BAMBOO            FSHKRSRS----------------MKRAEQIVTVM-KTIPLLG-EID------VGNLNI  3326
XENOPUS           YSHSRSRD----------------LTCSEQILTAL-KTIPLLE-ESK------TEYLTK  3339
STERLET           FSHTRSHT----------------QSSSEQILTVL-KTIPLLE-ERK------IDYTKA  3340
GAR               FKHLYSQA----------------QDSAEQILNVL-KTVDVLE-DSK------TDPEKE  3337
LATIMERIA         FGHSRSQS----------------QSCPERIQTVM-KTISLLE-ESK------ADYLNK  3334
CAECIL            YTHSRSQS----------------QTSPDQVLSVI-KTVSLLE-ETK------ADYLRE  3337
SNAKE             FSHSRSRS----------------QSNAEQILTVL-KTVFLLD-EIK------LSSVSN  3321
CANARY            FTHSSSRN----------------LSCPERVLSVL-KTISLLE-DTK------SDYLSK  3326
OSTRICH           FTHSCSRN----------------QSCPEQVCSVL-KTISLLE-DTK------SDYLSK  3296
GECKO             FSHSRSRS----------------QSNPEQILTVL-KTVSLLD-EAS------SGTLSK  3336
TURTLE            FSHSRSQS----------------QNSPEQMLTVL-KTISLLD-ESK------SDYLSK  3335
ALLIGATOR         VSHSSCQT----------------QSSPQQILTVL-KTVSLLD-ENV------PDHLSK  3293
PLATYPUS          CSHSQSQS----------------QSSPEKILTVL-KTVSLL-DDNL------SSYLSK  3325
TASDEVIL          FSHSRCQI----------------QSSSEQILTVL-KTVSLLADENL------SSYQSR  3330
HUMAN             LSHCRSRS----------------QGCSEQVLTVL-KTVSLLDENNV------SSYLSK  3318
MOUSE             LNHCRSHT----------------QSPREQVLNTL-KTITLLDESDI------SNYLNK  3318
CRASSO2           THQLSAMSA--------------DTDWTNDIFSSVI-TTIDRLGKFKD------SSLFER  3294
POMACEA           THQKKALSC--------------SGIWSKDMLYNVL-STLDPLSKVAE------SKMLRE  3303
TRICHOPLAX        VHCDKSLL----------------TPPDERLKTLL-TANSQFEKVKD------LSVILE  3315
NEMATOSTELLA      TQQKKAHG----------------LMAIDAVQTAL-STVSKLGKP-S------INTLAN  3299
PRIAPULA          TWQQIATGH--------------Q-RDSADRLHRLL-DTIKELDKHAG------KAVLHQ  3341
SOFTCORAL         LNCKKCPN----------------LLPSEAVDTAI-SALDQLDKIKD------SKVLQE  3333
PISTILLATA        VHFRKIQT----------------LTAVGAVETAL-LVAGQLDKFSA------SKILEI  3350
HEMICHOR          LHQKKCLT----------------LPPSKRVINLL-TTLDQLGMFTE------G----C  3335
BELCHER           LHQKKASL----------------LTGADKLNNVL-TTFEQLDKFSS------CRVFEE  3351
STRONG            MTQRKALL----------------LKPYERITSLL-KALDHLGKLPV------SHNLGS  3349
STARFISH          MNQQKILT----------------IELKEQVMTLL-TTFDPLAKLSN------TPALTG  3364
                                            .    :       :
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                RYG70459.1
ARCHAEON          NLVAFKNSKLGLEDAIVQRIYGDLLVLAKDMSARYPNARSPETSVGAL--DKYTRSVMLI  3792
MUDCRAB           DATIETEYLKLE---------SSLCVEISEAMKDMGNSWQED----------DKYIKSL  3306
SCORPION          LDVSTMNHYLLQ---------SEIIEMAADIVKYNDVH--------------AEKIQEL  3347
SPONGE            SKPFISQHHVLL---------GKLLNKMAEIFATPEDGMLAL---SALSNDGNTKLNSLI  3389
CAPITELLA         NAALLCDQHLLQ---------GEHLVTMATILQNQVKDIDAL-------DQKLLEKITES  3330
DANIO             SARMLRDQRILL---------GTTYDLMAGAADRSPFALETL-------GEEKVQKILQL  3360
MILII             HTRILRDQNTLL---------GSSYCILADALNKEPTCLQRI-------KEDQAERVIEH  3380
BAMBOO            QRHAFRDQNTLL---------GTTYYIMANALNKDPSCLQYI-------EEERAKNVKKL  3370
XENOPUS           NTKACRYQNMLL---------GDTYRIMADAVCKEPDCLYKI-------EDGKAGKVKDL  3383
STERLET           TTRIVRDQNILL---------GTTYHIMANALTRDGLALEHI-------GEDKAGKVLDL  3384
GAR               TAQNFRNQKLLL---------GTTYHIMASAVSRDPSVLEKI-------GPEKAGRVLKL  3381
LATIMERIA         NTRALRDQNILL---------GTTYNIIANALNKTPTSLQDI-------GEEKARKIQDL  3378
CAECIL            NTREFRNQNLLL---------GTTYSIIANALCKDPRCLQRI-------DKNKADKVLQL  3381
SNAKE             NAITFRNQNLLL---------GTTFHIMANALSKERSCLNQI-------GEEKARKVFML  3365
CANARY            NIMAFRNQNLLL---------GTTYQIMANALSQDPRCLEQI-------EKEKARKISLI  3370
OSTRICH           KVTAFRNQNLLL---------GTTYRIMADALSHDPRCLEQI-------EEEKARKVSVL  3340
GECKO             DRLAFRNQNLLL---------GTTFHIMANALSKDPRCLEQI-------VEEKARKVLVL  3380
TURTLE            NIVAFRNQNLLL---------GTTYHILASALSKDPGCLEKI-------EEEKARKVVML  3379
ALLIGATOR         NIEILRNQNLLL---------GTTYRIMAVALSKDPRCLVEL-------EEDKVRKVSML  3337
PLATYPUS          NIVASRNQKLLL---------GTTYRIMANALSKEPASLEQI-------ERNKARKVMEL  3369
TASDEVIL          NSLAFRNQNILL---------GITYNIIANALSNEPTCLAQI-------EESKAKKVLEL  3374
HUMAN             NILAFRDQNILL---------GTTYRIIANALSSEPACLAEI-------EEDKARRILEL  3362
MOUSE             NIQASCDQSILL---------GTTCRIMADALSREPACLSDL-------EENKVNSILTL  3362
CRASSO2           EAGLGRRHFVLL---------GQAFGLLVKGVQSENCFSSL-------SDKN-SEKIMGI  3337
POMACEA           KPALGMRHMILE---------SRTFDAVVTGLMSVGNLEEL-------GDKT-CEKLQQY  3346
TRICHOPLAX        NTTLMREHLLLR---------SRLLDMTSKILAESDASIL------DLLNEKKESLYQLA  3360
NEMATOSTELLA      DPVIALRHHILR---------SRCFDILTDAIAGAGRSTLATYKLICLINQPVDKSYCPC  3350
PRIAPULA          QRGLARENLLLK---------GRSIEAVAREVLTRPASLHTLP-----A-AT-REKLSLV  3385
SOFTCORAL         NASTGIRHHLLK---------SRNLDAITNVLSIPGTW--DSL-----EKEAKEKLHGLC  3377
PISTILLATA        EPLRGIQHHILR---------SKTFDILCKAMLDGGVVIATLE-----SQAKN-ALVKLC  3395
HEMICHOR          EPSYRKQHEILS---------GRSCHLVAQTIQEAGDDIFDVI-----HLKCRKS-----  3376
BELCHER           DLAVAKQHHTLT---------SLSYEIVAHALIQEGGAILTGL-----KDTRHAQLLTAA  3397
STRONG            DLFLLCDHRILT---------SKTYQSMASALQEEKGEMLTRL-----SDAGKLDKLLSK  3395
STARFISH          DYCLTRHHHTLT---------SKSYDLVAIAIQKGGADILTGL-----RNVGKLDKLLGL  3410
                                       .
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                RYG70459.1
ARCHAEON          EETATIEDMQREAIIVSLREKSYTCLARHSLQMLAKYKA------NELD-GAAGKDLVSV  3845
MUDCRAB           AEK-FPNAKDKSSWYKELLCCSYKSLKSAVNCGEEKFMQLNN--LYEGAHSHSKDIYMTL  3363
SCORPION          TDT-F-SIQSKSKLEIDLFCKNYEYKCRAIDIIQEVEQK-----MIEFDQATIGETYFKF  3400
SPONGE            GGT---PSTSTKAISEGLWIQALSSFNAGVRSGTTLNP-------LTKDPVPTVQSLEEL  3439
CAPITELLA         VGS---PALSHQEIVASLHEAAYNSFKSGVGVAASQPES----------VCVNKAYMSL  3376
DANIO             SQA---S--SIAQVVEGLQIQALELLRSAACKAEEEEQSFSQ---QHVNTHGIVEAYMTM  3412
MILII             SGS---SSEEIQEVVIGLHRKTLHYLERAVRKAEEEVQSLAG---EHVDIAGVIEAYVNL  3434
BAMBOO            SGA---TSDNPVQVSIGLYRKAHEYLQSAVKKAEEEVQSLSE---EHVDTVGVIKAYMTL  3424
XENOPUS           S-------ESPENVVGGLYRKSLHYFTNAVRKATEEEQSHST---DQIDVRGIIKAYMTL  3433
STERLET           LGT---TSDNLEQVVVGLHRKALQHLQNAVKKAEEELQSRST---EHIDIPGAIEAYMTL  3438
GAR               SGA---SSSNPQQVTAGFHKRALGLMQSAVKKVEDEVQSRSA---DHVDTAGAIEAHMTL  3435
LATIMERIA         SGA---QSDHPEQIVISLYRKALSYLQTAAKKAEEQVQSRST---EHIDVAGVIEAYMTL  3432
CAECIL            SGT---MSENPDEVAASLFKKSFHYLDSAVKKAEEEVQSRAM---ENVDTTGVIKAYMTL  3435
SNAKE             SEE---RSDNVEKVIAGLNKRAFLCFSGAVKKAEEEVQSMSF---DHIDISGIIDAYMTL  3419
CANARY            SGE---SLENPKKVLAGLNKKAFQCFSCAVRKTEEEVQSSSV---DHVDMVGVVDAYLTL  3424
OSTRICH           SGE---SLESPEKVLAGLNKRAFQCFSSAVRKSEEEVQSHSM---EHVDVAGVIDSYMTL  3394
GECKO             SGE---KTDDIGKVIAGLNTRAFQCFSSAVRKAEEEIQSLSF---DHINTKSIIDAYMIL  3434
TURTLE            SGE---RPENSEKVIAGLNKKAFQYFSTAVRKAEEEVQSHSM---EHVDLTGVIDAYMIL  3433
ALLIGATOR         SGE---KPDSPEKVIASLNKQAFQYFSNAVRKAEEEMQSRTM---EHVNLTGVIDAYLTL  3391
PLATYPUS          SGA---SFDNVQKVIAGLHRRAFQYLTHAVRKAEEEEQSHSS---EHVDTGGVIDTYMTL  3423
TASDEVIL          SGA---SSEDAEMVIGGLHKKAFECLFKAARRAEDEVQSHTT---EHVDIAGVIDAYMTL  3428
HUMAN             SGS---SSEDSEKVIAGLYQRAFQHLSEAVQAAEEEAQPPSW---SCGPAAGVIDAYMTL  3416
MOUSE             SGS---NAENTETVITGLYQRAFHHLSKAVQSAEEETQLSCW---GHEAAAERAHAYMTL  3416
CRASSO2           SKA---SKLNPRELARCLVEEGYNQMRKSLSYDGRG---------TRTCRYGLEEAYLAL  3385
POMACEA           TK----SPLNKGDLIKELIHHGYESLRKVISEVPEDS--------SRDAVCLQQDVQLAL  3394
TRICHOPLAX        NVN---QHDSKEKIAAKLTSHACQALHQAV------KAS-----KEERGGSSYIEAMMMM  3406
NEMATOSTELLA      NVC---LQ-----IVSQLITRSFTSLQEANKAAKQAATS-----SSDGSTTCMVEAMMAM  3397
PRIAPULA          AGA---REHDHTALVSGLISAGFRELREAVDVGDEEESSASL-------ASSPSAAHVAM  3435
SOFTCORAL         SSK---NPEQLDKILGHLTTKSFTTLQRAIKIAQTNENN----QKNAESVRNLVTSSMTM  3430
PISTILLATA        RID---ETESQKKVVSDLMTRSFVSLQSAIKAAKNAEGK-----CNTTQTSGTVDAMIAM  3447
HEMICHOR          --L---RSLIEALIVNGLQNKAHEYFKKGVKLASDEEDA------IDMDREGVIDAYVSM  3425
BELCHER           GVS---PDTSVDQTISSLLQKGHACLQKAVKLASDEEKA---RQDTSLDKSGIVDAFMAM  3451
STRONG            AEC---QESKPEKVCQSLFMKSKKYLDDAVGTIKLDPASHSLSSSAKREEQSMAKAHMAL  3452
STARFISH          VGQ---NATRPEQICSTLYSKAYSELKQAVSLADKDDA------VTSQSERSMTEAYMAL  3461
                                  :                                          .
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Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

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                                                                                                  RYG70459.1
ARCHAEON          TARCQQVLFDRAGVFAASN----------VAPEMLAHIVIESMIKGLSLQSSFCMERVL  3894
MUDCRAB           AKYCEDCLEKWKESID---------------VSDYADSLVMSVLRAMSLGSREAHFHFP  3407
SCORPION          ANYCNKILRMQEEEEKTLS----------LSFETYPSVLTNSLLNALKNGNLNAIKLFP  3449
SPONGE            FGFCDNALRQEDHDDEQST----------GLDTKSFPSIIINHTLTAMSLGSSKARELFP  3489
CAPITELLA         VHFCDQVLRQRENDEISGT---------KCESEEDFPLALVTSLLSAMKNSSKDARQLFP  3427
DANIO             ANFCDRRLRESEQKEEAI----------SSKLQSLPEHVVKMMLKALKLSSEEARLKFP  3461
MILII             ANFCDRCLREKEESATAIN----------FSEQQTFPACVVEKILKAMKYNSKEARLKFP  3484
BAMBOO            ANFCDRCLREEEESENINN----------FPELQTYPASVVENMLKALQYNSREARLRFP  3474
XENOPUS           VDFCDSHLRKVEEESAVMD----------RADYQNFPEIMVEKMIKALKLNSSEARLKFP  3483
STERLET           VNFCDKRLREEEESAEVST----------FSELPTFPAVVVDTMLKALKLNSKEARLKFP  3488
GAR               ANFCDKRLREEEENDQVSE----------FSELPTFPAIVVEQVLKALKLNSSEARLKFP  3485
LATIMERIA         VDFCDKRLREVEESAEVSH----------FSELQTFPAVVVENLLRALKLNSREARLKFP  3482
CAECIL            VDFCDTHLLKKEDTTAVID----------HSHLQQFPTIVVEKMIKSLKLNSKDARLKFP  3485
SNAKE             ANFCDSHLRKEEQNSADVN----------NEDLQIFPAIVVEKVIKALKLNSNEARLKFP  3469
CANARY            ISFCDQYLRREEEGLLEIN----------TVDLQQFPAIVVEKMIKALKLNSREARLRFP  3474
OSTRICH           VGFCDQHLRREEEGLLEIN----------TADLQLFPAIVVEKMIKALKLNSREARLRFP  3444
GECKO             ANFCDTHLRKKEEGSADIN----------AVDLQMFPAIVVEKVIKALKLDSKEARLKFP  3484
TURTLE            VDFCDKHLRKEEEGSSDVS----------ALDLQTFPAIVVEKMIKALKLNSRDARLKFP  3483
ALLIGATOR         VDFCDKHLHKEREGLSDIS----------AVDLQTFPTIVVEKMIKALKLNSREARLKFP  3441
PLATYPUS          VDFCDKHLRNEEEGTSVID----------AVVLQAYPALVVEKMMKALKLNSREARLKFP  3473
TASDEVIL          VDFCDRHLRKEEESTSVIH----------TVELQTYPALVVDKMLKALKLNSKEARLKFP  3478
HUMAN             ADFCDQQLRKEEENASVID----------SAELQAYPALVVEKMLKALKLNSNEARLKFP  3466
MOUSE             VGFCDQQLRKVEESASQKT----------SAEMEAYPALVVEKMLRALKLNSSEARLKFP  3466
CRASSO2           AQYCNKFLRMAEDDTDKESLNLS------KECQKNFPETITVCLLNAMKLDSMEARQRFP  3439
POMACEA           AKYCDKYLRLAEENDGL----VA------SESMEVFPATAVKCLLDAMRAGSAEALERFP  3444
TRICHOPLAX        VNFCDDILRHEEDGRANQ-----PKGL---IDTKIFPEVIIRYTLEAMAYNSMDARQRFP  3458
NEMATOSTELLA      VPFCDRALRRKEDESDGPSFIISPFGLHYEFVFQRFPEFVVRYVLKAMEHGSEEARNRFP  3457
PRIAPULA          ASYCDYFLRVREDDGTTV------------LPTDGYAETVITSLLRAMALGSSEARDSFP  3483
SOFTCORAL         ANFCDRLLRMKEEDSEQTP----------RLDMKLFPGIVIRFVLKSMAFESAEARQKFP  3480
PISTILLATA        VNFCDNCLRKKEVSVAPVE----------VDTKLFPGIVVRYMLKSMCYSSKEARQKFP  3496
HEMICHOR          ATFCDKMLKQQEQNEDGAV--------SRSSKSPSFPRSVVFHLLKALKLNSVEAIQRFP  3477
BELCHER           VGFCDKILRHQEDDEEGTE----------LSSIPGLAAAVVSNLLQALRHDSPEARQRFP  3501
STRONG            VSFCDQLLRQQDDDDCNPD---------YLPLMEAYPSTVVNSTLQAMNLNSPEARQHFP  3503
STARFISH          VSFCDRMLRLKESDEVPMT---------YLPQTDNFSQTVVHYTLKAMHYSSQEARQRFP  3512
                     *:  *                                  : .:   .  .   .
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                  RYG70459.1
ARCHAEON          VLHIAKTYPHALHYSFRITCEVNS-----SISLNKAKYSQLHSLLAN----KSIDDFVEA  4005
MUDCRAB           VEKLALEYPQAIVYPFRISMKQYDFTGS-VGKAAQSMCQRVESSLCKN---SLFHHFVTA  3513
SCORPION          IKEIGTNFPNALVYPFKLSYEMYKFPDTLQGKENKEFVMKLKSSLSQL---KLVDEFVNA  3556
SPONGE            LIRIADTYPQSLYYAFRMSSSGYKFGHNNS--EGKELFEKLKEKLQS----QLMDEFIAA  3593
CAPITELLA         LLNIADIYPNALVFPFKLSNHNYKFTSDAVSSKSKSVCDRLHQMLSKN---PLIDRLIFS  3534
DANIO             IEEIAECYPQALIYPYMISSENYTFEESASGQRNREFVEKLESLLDKG---GVIQGFVDA  3569
MILII             IEEIADSYPQAIVYPLMISSESYTFEQTARGNTNKEFVERLKNKLDKG---GMVEVFINS  3592
BAMBOO            IEKIADSYPQAIVYPFKISSENYTFEPSANGNKNKEFVERLKTKLDKG---GVVESFIHS  3582
XENOPUS           IEEIAENYPQALVYPFMVSGESYNFEDTVVGHKNREYVNRIKSKLDKD---NVAQDFIRA  3591
STERLET           IKEIAEYYPQAILYPFMISSENYVFEDSATGHRNKEFVARLKSQLDKG---GVVKNFIDA  3596
GAR               IQGLAESYPQAVVYPFMISSETYQFEDSATGHRNKEFVTRLKDQLDKG---GVVKDFVEA  3593
LATIMERIA         VEKIAESYPQAIVYNFMISSESYSFEESPKGKKNKEFVARLKSELDKG---AVVEDFIHA  3590
CAECIL            IEDIADAYPEALVYPFMISSENYSFEDTATGHKNREFMLRIKSKLDKG---GMVQDFIQS  3593
SNAKE             VEEIASSYPQAIVYPFMISSESFSFPETAIGHKNKEFVKRVKSKLYEG---GVIQDFAHS  3577
CANARY            VEEIANTYPQALVYPFMISSESYCFKDTAAGCKNKEFVERIKNKLDRG---GVVQDFVHS  3582
OSTRICH           VEEIANTYPQAIIYPFMISSESYSFKDTVTGCKNKEFVERIKKKLDRG---GVVQDFVHS  3552
GECKO             VEEIANSYPQAIVYPFMISSESFSFQDTIIGHKNKEFVARVKSKLDRE---GVVQEFVQA  3592
TURTLE            VEEIANSYPQAIVYPFLISSENYSFKDTATGHKNKEFVARIKSKLDRG---GVIQDFVHA  3591
ALLIGATOR         VEEIAHNYPQAIIFPFMISSENYSFKDTATGHKNKEFVTRIKSKLDRG---GVIQDFVQA  3549
PLATYPUS          IEEIADNYPQAIVYPFMISSENYSFKDTSAGHKNKEFVTRIKSKLDKG---GVVQDFIQA  3581
TASDEVIL          VAEIADNYPQAIVYPFMISSENYSFKDTSAGHKKKEFVLRIKSKLDQG---GVVQDFINA  3586
HUMAN             VEEITDNYPQAIVYPFIISSESYSFKDTSTGHKNKEFVARIKSKLDQG---GVIQDFINA  3574
MOUSE             VEEIADNYPQAIIYPFIISSESYSFKNTSSGHNNKAFVERIKSKLDHG---EVIHSFINA  3574
CRASSO2           LTELAETYPQAVVYPFKLSSEGYKFTNKKD----EAFVTKLGSTLGDE-QLPLVPKFISA  3544
POMACEA           ILRIATEYPQAIVYPFHISQESFTFGSTAEDRRNKQGIEELDALLSEE-RVPLVRTFISA  3553
TRICHOPLAX        LFRIADEYPQAIIYAFKVSNEQYTFEETSVGRQNKTAVSKLSSKLQL----PLIESFVRA  3564
NEMATOSTELLA      VTEIAKNYPQALCYAFKVSSEQFVFDSSPEGNTNRKAVERIRKLLES----PLMDSFIAA  3563
PRIAPULA          LLSIAESYPQALIYPLNLSREHYTFTVDAAGAEAEAYLHRLLATLSTCMDMSQLQQLVAS  3593
SOFTCORAL         LQDLAKHYPQALLYPLKISAEQFKFGGSIEEQKNKKFVESLNESLSF----PASDDLIQA  3587
PISTILLATA         VSEIAKRYPQALWYPFKISSEHFVFENSEDGKANEEAVKRLRSSLEH----PLLDDFIAA  3602
HEMICHOR          LLEIANNYPQALVYPFKVSSENFSFENTVTGKRNKEKVSQLAAILDNV---PLVMHFICA  3584
BELCHER           LTRIAQEYPQALVYPLKISSENFEFEDSVTGRRNQEAVTSLKKTLSVIY--SLVDKLIGG  3609
STRONG            LKAIAKDYPQALVYPFKISSEDFKLGDKSKEKQRKDAVKEIEDILSTV---PLVENLTLA  3610
STARFISH          LTDIAYEYPQALCFPFKISSESFTFDESNTGRKNASAARKIGAILESI---PLLDDFICA  3619
                  :  :   :*.:: :   ::                    :   *          :  .
```

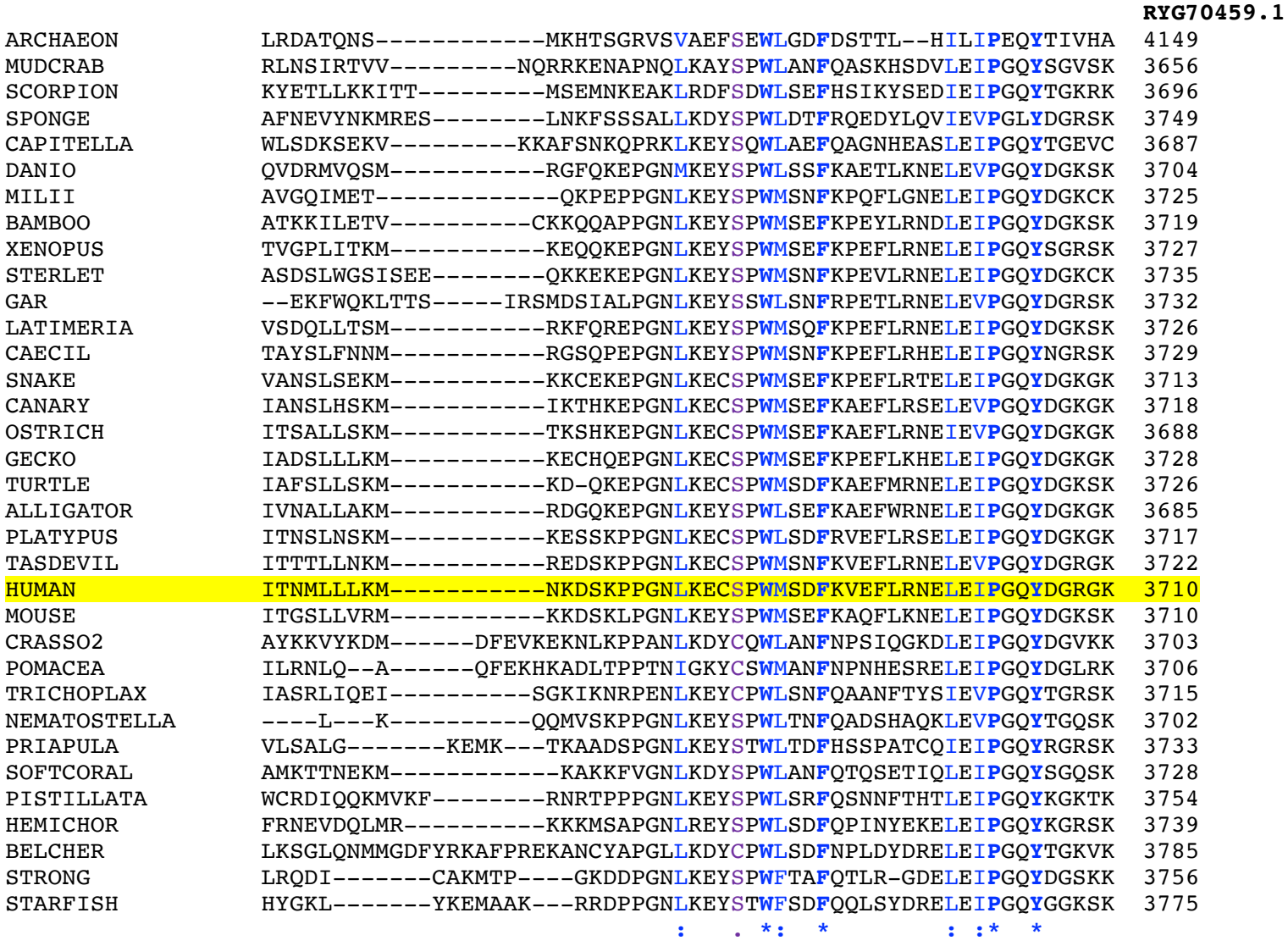
Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                RYG70459.1
ARCHAEON            LLACSHPELRFSDAVKSIDSLLAKNTN-TNLTSAVKQQVLNLLDEVYTFCLSQ-------  4057
MUDCRAB             MSLIVVPENTLKKSFKKILLIK-----------NKEDIEVALNNLVADHLKVNNRSTRG  3561
SCORPION            LDSLSVPELLYKEYFKEILQMKKD--------KGDKNEIVKLYKKLCHELFNYNPRDKMK  3608
SPONGE              LEQLNSPELAWKDWYDNELKPLVGS---VTVPKRDKNAIKRVWEQMYSQLLETRSGLGDK  3650
CAPITELLA           LEMMHEPAVIIKDWIMDMKNAKGPGG---SSQSLSMAYVKERYQELYKELLCIESEDGSL  3591
DANIO               LQQLSNPEMLFKDWWDEVKNQLDKP-------NLDKKKMKLQY--MTELLGDA-------  3613
MILII               LEQLSNPDMLFKDWVDNFRSKLEKK-------E-NKTQLKNLYSEMYSNLANA-------  3637
BAMBOO              LEQFSNPDLLFKDWANDFKTELEKK-------VKDKKLLKNMYDEMYSNLASL-------  3628
XENOPUS             LEQLSNPPMIFQDWWEDVSNELSKP-------NVNKNKIKELYKEMYTNLGNP-------  3637
STERLET             LQQLTNPEMLFKDWVEDVKKELEKP-------KTDKKLLKNMYEEMYSALGNP-------  3642
GAR                 LQQLSNPEMLFKDWLEDARNTLSKP-------KTDKKDAKKMYEEIISVLGNA-------  3639
LATIMERIA           LEQLTNSDMIFKDWVDDVRNELDKP-------QRNKANLKRMYEEMYANLGNL-------  3636
CAECIL              LEQLSNPDMIFKDWIEDMKNELAKS-------QRNKNNIKKLYEEMYMNLGNL-------  3639
SNAKE               LEQLSNPAMLFKDWIGDVQNELGKT-------KKNTNNIQQLYDGMYQNLGNL-------  3623
CANARY              LEQLSNPVMIFKDWAEDVRNELSKP-------QRNKKKLKEMYERMYKNLGNL-------  3628
OSTRICH             LEQLSNPMMLFKDWTEDVRNELVKT-------QRNKNKLQDMYERMYRNLGNL-------  3598
GECKO               LEQLSNPVMLFKDWTDDMKNELGKT-------KRNKENILKLYDGMYQNLGNV-------  3638
TURTLE              LEQLSNPVMLFKDWVEDVKNELGKT-------QRNKNNLKEMYEGMYRNLGDL-------  3637
ALLIGATOR           LEQLSNPEMLFKDWVDAVRNELGKA-------QKNKAKLKEMYEGMYGNLGNL-------  3595
PLATYPUS            LEQLSNPEMLFKDWVEDIKIELTKT-------PINKNNLKRMYEGMYKTLGNL-------  3627
TASDEVIL            LEQLSNPELLFKDWVDDVRGILMQT-------PVNKKKLEKMYEEMYAILGTL-------  3632
HUMAN               LDQLSNPELLFKDWSNDVRAELAKT-------PVNKKNIEKMYERMYAALGDP-------  3620
MOUSE               LDQLSNPDLLFKDWVSDTKDELGKN-------PVNKKNIEKLYERMYAALGDL-------  3620
CRASSO2             LEHMSQPDQIFKDWFDDTRLKFMKN-------KPDKKAMKEEYQIMYKKVLEFTETVGRG  3597
POMACEA             LEQFSQPVQMFQDWSRDITKILE-K-------RP-AAEIKKKYKEIYDMLLEMPHKGEQS  3604
TRICHOPLAX          LEQLSQPDLVFKDWVDEVKGL---K--------KKSGSIAESIRICYQKLRDGLLVDASN  3613
NEMATOSTELLA        LEQLHNPEMAFKDWCDGEIKQLLQT--------KNKKAIKEAFRSIYKQLFDSSVNRATD  3615
PRIAPULA            LEQLSSPHMLFSDFVADARPLLMTR----------RADFPARFRKIYASLFDTTRRSQEE  3643
SOFTCORAL           LEQLTNPEMVFKDWMDEVKVLLS--------TKGNAVKIRESYGEMSKKLLNVKKR----  3635
PISTILLATA          LEMLTNPEMVFRDWCEGPMKQLLED----QIKRNDSQAVKQCFGAMFQLLMDCRKRTKS-  3657
HEMICHOR            LEQLTNPEHICKDFTDDVLVPALRAR--------NPTAVKKAVEGLYTRVFDSKRQSSQD  3636
BELCHER             LEQLSHPDQLFKDWGDDADLKRLLKVDPKKRTKEDKVTIKRLYDEMYDSLLDFRSASQDS  3669
STRONG              LQRLTHPGFIFKDWISVIN-SKM------NSKERDHPAIKQEYQQLYQQLFES-------  3656
STARFISH            LEQLNNPEFVFKDWADDVMKPLL------NVAKRDKNKIRQACHEIYMNLINHRSTVTDT  3673
                    :            .
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                RYG70459.1
ARCHAEON          ----------SWPRIGHKIGKYNRHFAKALLPKVN---SIVGSKRESIFNKDVLGKLKE  4103
MUDCRAB           MAG--------EKGEVFCKVGKLKKDVNVALTK-------EFGGKMEEFKRMPV-EEIKK  3605
SCORPION          -------------------ERKLHLKVAKVCGSVVF---SEFGKDGNKLISMPL-KEASV  3645
SPONGE            ---SLY------GGSPSLQKGARQKTFAQAYAKNIE---DKFGKGGAKIISMSG-TQLAS  3697
CAPITELLA         ----------YSDSADCSMGPYRSDFVKQFISQFD---EYFGKMGSKIPGLTF-MKVLS  3636
DANIO             ---------------KSPRFGSYRRKFIQKFSKEVE---KLLGAGGSKLYERRKDKDFLQ  3655
MILII             ---------------GAPGIGAFRRRFVTGFKKKID---QHFGKDGLLLLNMN-LKAFNV  3678
BAMBOO            ---------------QFPGIGAFRTRYVQVFKKAFD---QYYGKEGSRLLDMN-IKIFDE  3669
XENOPUS           ---------------KDHFMGAFRRRFCEKYTKDFD---KAFGPEGSKLLNIK-CDGFNK  3678
STERLET           ---------------RCQGIGAFRKKFAQHFSKEFD---KTFGKGGAKLFDMK-HDAFRK  3683
GAR               ---------------KAAGIGRFRKKFVETYAKRIEEIVKELGKDGSKLWDKR-KD----  3679
LATIMERIA         ---------------RAPGLGSFRSNFVKAYGKEFE---RVYGKRGEKLLDMK-SSDFFK  3677
CAECIL            ---------------KAPGIGEFRRRFVQAHAKDLD---THFGKGGSKLVDMK-EDAFAK  3680
SNAKE             ---------------EAPGLGWYRKQFIKEFGKELD---IHFGKGGSKLLGMN-ASVFIK  3664
CANARY            ---------------ESPGLGMMRKRFIQAFGKDLD---HHFGRGGSELLNMK-TSDFDA  3669
OSTRICH           ---------------EAPGLGLLRRRFIQAFGKDFD---HQFGKRGSKLLNMK-ASDFDA  3639
GECKO             ---------------HASGLGLFRKRFIEKFGKEFD---SHFGKRGSKLLDMK-ASGFNT  3679
TURTLE            ---------------QAPGLGLFRKRFVQTFGKDFS---SHFGKGGSKLLDMK-ADDFNR  3678
ALLIGATOR         ---------------QASGLGLFRRRFIQAYGKEFD---TQFGKGGSKLLDMK-DNEFIK  3636
PLATYPUS          ---------------KAPGLGAFRKRFIQAFGNEFD---HHFGKGGSKLLQMK-LSDFTS  3668
TASDEVIL          ---------------EVPGIGAFRKKFIQTYGKEFD---RHFGKRGSKLLVMK-LSDFNN  3673
HUMAN             ---------------KAPGLGAFRRKFIQTFGKEFD---KHFGKGGSKLLRMK-LSDFND  3661
MOUSE             ---------------RAPGLGPFRRRFIQAFGKEFV---KSFGNGGSKLLTMK-VDDFCK  3661
CRASSO2           ASQ----RSQTEETLSMVDKGKYPKKFAERFKKDVD---SCFGKNGEKILDMSF-SKLAG  3649
POMACEA           GTQ------AQQTSFGAVSMGEFHRRFAEVFKNEFD---NHFGVDGSKLVTMTA-KEFSG  3654
TRICHOPLAX        ESE----AASSLTSGELIEFGSHKRRFIQHFGKVIE---QYFGKDGSKLQSMKA-SDFEK  3665
NEMATOSTELLA      SSQ----------PAAEEMGPFRKKFSKEHASRFE---NIFGKDGEKLVNMSL-KTAK-  3659
PRIAPULA          ----------------PGGRGRYWSVFTRTWAREVE---EKCGRDGSKLLAMAA-ADANQ  3683
SOFTCORAL         ----------GTNSDGLEFGSIRRKFAQEFSGNVV---KVCGEDGSKIIDMSI-KAFES  3680
PISTILLATA        ----------GSQTRGTESGPFRTKFAQEFANEVQ---RIFGKEGEKLVGVKM-TDFSK  3702
HEMICHOR          ---SLF-SEDSDAVTQSLPFGPFQKKFASDFVKPFQ---KRFGERGCKILSMQHQKEFMN  3689
BELCHER           SMSSLFGSQSSDLESQSVGFGPFRRRFAQQFAKECE---KMFGKDGSRILDMKE-KEFMK  3725
STRONG            GGR----QGGPSSSSQTVEPGPYWKKFGREWQKRFD---SSFGQDGSKLAAMDY-KTWSK  3708
STARFISH          GAG----SSQDSQSSPSVGFGNFRRRFAQEWQKKFE---AAFGKDGTKVIDMQL-KTFSE  3725
                                                          *     .
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"



Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                  RYG70459.1
ARCHAEON          -TPREPEVINTIAGELLVMESIRKPKRLSLVSNTGVGYRFLVKGGEDLRNDERIEQLFGL  4208
MUDCRAB           PLPEYHVNISSFDENVMPMQSLRVPLRIVIRGSDEKDHKYLVKWGEDLRTDQRMQQVFTL  3716
SCORPION          PIPEHHVKICNFDQKVDILSSLTKPRCLTIRGNDQKDYKFLVKSGEDLRQDSRIEQLFDV  3756
SPONGE            PLPEYHAKITRFDAKVLILSSLRKPKRLTIIGDDTREYMFLVKGGEDLRLDQRIEQLFET  3809
CAPITELLA         PLPEYHAKISSFDSQVTVLRSLRMPKSIVIRGNDEKEYKFLVKGGEDLRQDQRVQQVFNL  3747
DANIO             PLPEYHAKITGFDERVKVMTSIRRPKRIIIRGDDERDYPFLVKGGEDLRQDQRIEQLFGV  3764
MILII             PLPEYHAKITGFDERVKVMSSIRKPKRLIIRGNDEKEYPFLVKGGEDLRQDQRIEQLFEV  3785
BAMBOO            PMPEYHAQITGFDERIKVMSSIRKPKRLIIRGNDEKEYPFLVKGGEDLRQDQRIEQLFDI  3779
XENOPUS           PMPEYHVKISGFDERVSVMASIRKPKRIIVRGNDEREYPFLVKGGEDLRQDQRIEQLFEI  3787
STERLET           PLPEYHARITGFDERIKVMSSMRKPKRLIMRGNDEREYPFLVKGGEDLRQDQRIEQLFDV  3795
GAR               PLPEYHVKITGFDERVQSLRSIRKPKRLIIRGSDERDYPFLVKGGEDLRQDQRIEQLFGV  3792
LATIMERIA         PMPEYHAKITGFDERIKVMASIRKPKRLIIQGNDEREHPFLVKGGEDLRQDQRIEQLFEV  3786
CAECIL            PLPEYHVKISGFNERVKVMSSIRKPKRIIILGNDEKEYPFLVKGGEDLRQDQRIQQLFDV  3789
SNAKE             PLPEYHAKISGFDERIKVMQSMRKPKRIVIRGNDEREYPFLVKGGEDLRQDQRIEQLFEV  3773
CANARY            PLPEYHAKISGFDERISVMESLRKPKRITIRGSDEREYPFLVKGGEDLRQDQRIEQLFDV  3778
OSTRICH           PLPEYHVRISGFDERIKVMESMRKPKRITIRGSDEQEYPFLVKGGEDLRQDQRIEQLFDV  3748
GECKO             PLPEYHAKIAGFDERIKVMLSIRKPKRIIIRGSDEREYPFLVKGGEDLRQDQRIEQLFDV  3788
TURTLE            PLPEYHAKISGFDERIKVMESIRKPKRINIRGSDEREHPFLVKGGEDLRQDQRIEELFDV  3786
ALLIGATOR         PLPEYHAKISGFDERIKVMESLRKPKRIIIRGSDEREYPFLVKGGEDLRQDQRIEQLFDV  3745
PLATYPUS          PLPEYHAKITGFDERVKVMASIRKPKRIIIRGHDEREYPFLVKGGEDLRQDQRIEQLLDI  3777
TASDEVIL          PLPEYHAKITGFDERVKVMASIRKPKRITIRGNDEKEYPFLVKGGEDLRQDQRIEQLFEV  3782
HUMAN             PLPEYHVRIAGFDERVTVMASLRRPKRIIIRGHDEREHPFLVKGGEDLRQDQRVEQLFQV  3770
MOUSE             PLPEYHVRISGFDERVKVMLSLRKPKRIVIRGHDEKEYPFLVKGGEDLRQDQRIEQIFEV  3770
CRASSO2           PMPEYHIKVVGFDQRVKVMTSIRKPKRITIRGNDEREYHYLVKGGEDLRQDQRIEQLFFL  3763
POMACEA           PMPEYHVKVAGFDERVLVMSSLRRPKRITIRGNDEKDYHYLVKGGEDLRQDQRIEQLFVL  3766
TRICHOPLAX        PLPEYHLKIASFGERLLVLKSIRKPLRLTVQGDDEKEYLFLVKCGEDLRLDQRIEQLFCV  3775
NEMATOSTELLA      PMPEYHVNIAGFDEKVLVLASIRKPKRVTIRGDDERDHMFLVKGGEDIRLDQRIEQLFCM  3762
PRIAPULA          PMPEYHVKIAGFDEKVLVMKSLRLPKRITIRGHDENEYMFLVKGGEDLRQDQRLEQLFDI  3793
SOFTCORAL         PLPEYHVKVAGFGEKVKAMSSLRAPKRITILGNDEREHTFLVKGGEDLRLDQRIQQLFGL  3788
PISTILLATA        PLPEYHVKIVGFDEKVQVLPSIRKPKCLIIRGDDEKDHMFLVKGGEDLRLDQRIEQLFGL  3814
HEMICHOR          PLLEYHVKIAGFDEKVKVMSSLRKPKRLTIRGNDEKEHNFLVKGGEDLRLDQRIEQLFGI  3799
BELCHER           PLMQYHAKIAGFDQRVKVMSSLRKPKRVTIRGDDERDHPFLVKGGEDLRQDQRIQQLFDI  3845
STRONG            PLPAYHVKIAGFDETVLTLSSLRKPKCITIRGNDEMDYPFLVKVGEDLRMDQRIEQLFCI  3816
STARFISH          PLPEYHVKIAGFDEQVKVLSSMRKPKRIVIRGNDEHDYSFLVKGGEDLRLDQRVEQLFRI  3835
                         :  :   :  : *:  *  : : .     : :*** ***:* *.*:::::
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                  RYG70459.1
ARCHAEON          MNQIVRKHERYSVEQDIVFNQALDFSQPVPRYLLPEPATRPTLQADTGVKALEAL--RAR  4266
MUDCRAB           MNSVYSSSPLCA-----------------------------------------HTSFHPSLD  3737
SCORPION          MNDIYQCNAICF-----------------------------------------QNKL--KLE  3775
SPONGE            MNKVLSDDPICS-----------------------------------------QRRL--NLR  3828
CAPITELLA         MNEIYANDANCH-----------------------------------------ARRL--QLK  3766
DANIO             MNMILSQDTACS-----------------------------------------QRSL--ALR  3783
MILII             MNIILSRDAACS-----------------------------------------QRSL--QLK  3804
BAMBOO            MNIILSRDAACS-----------------------------------------QRNL--QLK  3798
XENOPUS           MNIILSQDAACS-----------------------------------------QRHM--QLK  3806
STERLET           MNIILSRDATCS-----------------------------------------QRNL--QLK  3814
GAR               MNIILSQDAACS-----------------------------------------QRNL--GLR  3811
LATIMERIA         MNIILSQDAACS-----------------------------------------QRNL--QLK  3805
CAECIL            MNIILSQDAACS-----------------------------------------QRNM--QIK  3808
SNAKE             MNNILSRDAACS-----------------------------------------QRNM--QIK  3792
CANARY            MNIILSQDATCS-----------------------------------------QRNM--QLK  3797
OSTRICH           MNIILSQDAACS-----------------------------------------QRNM--QLK  3767
GECKO             MNTVLLQDAACS-----------------------------------------QRSM--QLK  3807
TURTLE            MNIILSQDAACS-----------------------------------------QRNM--QIK  3805
ALLIGATOR         MNIILSQDASCS-----------------------------------------QRNM--QIK  3764
PLATYPUS          MNIILSQDAACS-----------------------------------------QRNM--QLK  3796
TASDEVIL          MNIILSQDAACS-----------------------------------------QRNM--QLK  3801
HUMAN             MNGILAQDSACS-----------------------------------------QRAL--QLR  3789
MOUSE             MNAILSQDAACS-----------------------------------------QRNM--QLR  3789
CRASSO2           MNQALESDPACK-----------------------------------------QRNL--KIK  3782
POMACEA           MNKVLEKDPVCK-----------------------------------------ARRL--VLK  3785
TRICHOPLAX        MNEILAQDSICS-----------------------------------------QQDL--RLR  3794
NEMATOSTELLA      MNEVMSEDPACS-----------------------------------------QRNL--RLR  3781
PRIAPULA          MNRSLDADAACR-----------------------------------------QRAL--RLR  3812
SOFTCORAL         MNDVMRDDAACH-----------------------------------------QRNL--SLK  3807
PISTILLATA        MNDIMANDSACS-----------------------------------------QRGL--RLR  3833
HEMICHOR          MNDILALDAACS-----------------------------------------QRSL--KLV  3818
BELCHER           MNDILTLDPACS-----------------------------------------QRQL--RIR  3864
STRONG            MNSILAQDAACS-----------------------------------------QRGL--TLT  3835
STARFISH          MNSILEQDSTCS-----------------------------------------QQGL--QLV  3854
                  **                                                        :
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                RYG70459.1
ARCHAEON          TYGVVPMSTKVGILEWVPNTISLRAILAEEMVKDDYIQKTQRQAIEEKDGHLELSLFALS  4326
MUDCRAB           TYQVIPLSSEVGMLKWVESTQPLLDFIKDSFKEGEAKCLDEAE-------------T---  3781
SCORPION          TYQVIPLTTKIGLIEWVDNTNVLGSFLKDAMTDKEKESFR-----------------ESD  3818
SPONGE            TYSVIPVTPRVGLIEWVRNTMPLKDFIQLSDPEKKSLP---------------------A  3867
CAPITELLA         TFQVIPMTPRLGMIEWLKNSCTLKDFLRQGCSDVSWEQIQNKN-------------LPNN  3813
DANIO             TYQVIPITSRIGLIEWMENTCTLKDFLSSRRTEQEQKT-------------------ITR  3824
MILII             TYQVIPMTSRLGLIEWLDNTCTLKDFLSSNITEETQSRRQ-----------------QE  3846
BAMBOO            TYQVIPMTSRLGLIEWLDNTCVVKDFLLSNMTEDEHKRPS-----------------P-  3839
XENOPUS           TYQVIPMTTRIGLIEWLENTCTLKEFILNTMTEDEAKIYNSKT--------------TNG  3852
STERLET           TYQVIPMTARIGLIEWLENTCTLKEFLFDRMTEEERKH-------------------CKR  3855
GAR               TYQVIPMTTRIGLIEWLENTCTLKDFLDSRRTEPEEKS-------------------SPS  3852
LATIMERIA         TYQVIPMTTRIGLIEWLENTCTLKEFLSNAMTEEERTNYETLS-------------PKKG  3852
CAECIL            TYQVIPMTTRLGLIEWLEATNTLKDFLYNSMSEAEQENCS--S--------------T--  3850
SNAKE             TYQVIPMTTRLGLIEWLENTYTLKEFLLKNMSEQEKNCYN--S--------------SQG  3836
CANARY            TYQVIPMTTRLGLIKWLENTCTLKEFLKNSMSEEEDINYY--S--------------PRG  3841
OSTRICH           TYQVIPMTTRLGLIKWLENTCTLKEFLKNSMSEEEDFNYS--S--------------KKG  3811
GECKO             TYQVIPMTTRLGLIEWLGNTCTLKEFLLQNMSEQEKNDYN--S--------------SKG  3851
TURTLE            TYKVIPMTTRLGLIEWLENTCTLKNFLMESMSEEEKDDYH--S--------------RKG  3849
ALLIGATOR         TYQVIPMTTRLGLIEWLPNTCTLKNFLHSNMSEEEKADYC--S--------------EKG  3808
PLATYPUS          TYQVIPMTTRLGVIEWLENTCTLKELILKSMSEGEKAAYE--S-------------NPKG  3841
TASDEVIL          TYHVIPMTTRLGLIEWIENTCTLKELLLNNMSEEEKAAYE--S-------------GPKA  3846
HUMAN             TYSVVPMTSRLGLIEWLENTVTLKDLLLNTMSQEEKAAYL--S-------------DPRA  3834
MOUSE             TYRVVPMTSRLGLIEWIENTMTLKDLLLSNMSQEEKVANN--S-------------DPKA  3834
CRASSO2           TYQVIPMTSRVGLIEWMNDTIPLKEFLICNLTEQEAKFVS--------------------  3822
POMACEA           TYQVIPMNTRVGLIEWMSNTIPLKEFLLNAMTEKERTAYF--G-------------E-NG  3829
TRICHOPLAX        TYQVIPITQRLGLIEWMKNTITLKEFVTDAMEDHEKQHYL--S-------------SQNS  3839
NEMATOSTELLA      TYQVIPMTQRVGLIEWLKNTKPLKELLHIAATESEKQAMV--V-------------RRKT  3826
PRIAPULA          TYAVVPMSTRLGLLEWVPRTKPLKQLLQEAMTQQQYDAYY--S-------------YSMN  3857
SOFTCORAL         TYKVIPMTSRIGVIEWLENTTVLKEFIRNGLSETENETFD--T-------------I---  3849
PISTILLATA        TYQVIPMTPRVGLIEWMNNTKPLKGVLNSAMTKAENDHYI--G-------------P-NG  3877
HEMICHOR          TYEVIPMTPRIGIIEWVDHCLPLKVFLSEAMTKNERSHYA--N-------------T---  3860
BELCHER           TYGVIPMTSRVGLIEWMQNTTPLAGFLENAMTTREQEAFL--H-------------Q-RL  3908
STRONG            TYQVVPMTPRLGILEWVKRTTTLKDFITRSMTEAEHKVYT--S-------------RTTG  3880
STARFISH          TYEVIPMTPRLGMIEWAQNTTTLKEFLHLAMTEQEGNAYN--S-------------R-HG  3898
                  *: *:*:. .:*:::*      :  .:
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Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

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                                                                                RYG70459.1
ARCHAEON          SAELRTNWLK----------GNGTTDYHQMYRNAPLASAAAVYDAITSILPTYYLQRRL  4375
MUDCRAB           FYRTEEPWNF--------------------RKKTTDKRRVKKYEDAVNRIPWDILRRGL  3820
SCORPION          PKMTFYKFLLSKTNS----RDKSIPLLYENIYKI-ADTEVNKKFTECINMIPWDLFRRAF  3873
SPONGE            ASKMNQKWLEQKFGG------SNYVNWYYEMYKKLKADEVKKEYRRIVSAVPWDLLRRSL  3921
CAPITELLA         PANLLCQWIGDSSNT------RQMIENYRKCYQKYSRNETLNAFKKREAMVPWDMLRKSY  3867
DANIO             PNEFYDEWISKVAG------KVEGIRRYAELYKKAKRVDTVNNFRRIEQMVPDDLLKRAF  3878
MILII             VLPKYREWLQKMAGR-----K-DMFLRYPTMYLKASRTETVTAFRTHEQAIPGDLLRRAF  3900
BAMBOO            -KELFSEWLQRISGS-----KSDVTTLYGQMYMKASRTETVKAFRQCERAVPPDLLRRAF  3893
XENOPUS           PLYHYNAWLDKKEK-------VGDARQHVTSYTRCDRTNTVASFREREALVPKDLLRRAF  3905
STERLET           PAESYMEWLSKVAG------KEKGIAQYITMYKTAKRTETVRAFRNVEHHVPEDLLRRAF  3909
GAR               PQDMYSAWLEKISR------RSKGQEQYHEVYKKASRTETVANFQSIEKLVPQDLLRRAF  3906
LATIMERIA         PKAQYNEWLTKMAGG------SVGPQRYGSMYKRASRTETVMAFRSVESLVSRDLLRRAF  3906
CAECIL            -TKHYKDWIQKMGR-------CDNISRYEYMYRRASYTETVVAFKARENLVPGDLLRRAF  3902
SNAKE             PFADYKDWLCKMGE-------RNRIECYMTMFKRASRTETVMSFQHRENRVPEDLLRKAF  3889
CANARY            PRATYSEWLSRMGG------KAQGISRYHAMYRNASRTEAVTSFKSRESSVPEDLLRRAF  3895
OSTRICH           PRATYNEWLSKMGG------KAQGVPRYHVMYRNANRTETVMSFKSRESSVPEDLLRRAF  3865
GECKO             PRADYNEWLSKMGD------RNAGLVNYVSMYKKASRIETVTSFQQRENLVPEDLLRRAF  3905
TURTLE            PRIMYSDWLSKMAGK------ENGIARYKTMYSRANRTETVLSFRNRETSVPGDLLRRAF  3903
ALLIGATOR         PLFAYNEWLSKMAGG-----KIEDFARYMPMYKRASRTETVMSFRNRENRVPEDLLRRAF  3863
PLATYPUS          PVHEYSEWLYKMSK-------KQDFGAYMLMYKHASRTEAVTAFRNRENRVPGDLLRRAF  3894
TASDEVIL          PQLEYSTWLTKITG-------KQDISAYMLMYRRANRTETITSFRNRESKVPADLLRRAF  3899
HUMAN             PPCEYKDWLTKMSG-------KHDVGAYMLMYKGANRTETVTSFRKRESKVPADLLKRAF  3887
MOUSE             PIRDYKDWLMKVSG-------KSDAGAYVLMYSRANRTETVVAFRRRESQVPPDLLKRAF  3887
CRASSO2           -GNLHNSWIMKLSKD-----PRDVQQGYMQMYLKYNMTETRRELQKKENIIPWDLSRRAF  3876
POMACEA           PSQLHYKWLPKLPKK------TDWGLIYGQVYQNYSKTETMKEFRIKESKVPWDLSRRAL  3883
TRICHOPLAX        PHQLYSKWLGKFGSA------GGPVYMYQSMYRKAKRSEVENHFKFRENSVPWDLLRRGF  3893
NEMATOSTELLA      KNMLDL---------------TLRILFDIIISREANRTDTESEFKKKQAQVPWDLLRRAF  3871
PRIAPULA          PVEHFNKWAATALTASESKRAASHVKLYARTFVQCSKSDTVRSFRERESMVPPDLLRQAF  3917
SOFTCORAL         -GYKHNKWIVEKFPV---NGNKHIINNYYPMFKKASREVIERKFRELQNLMPHDALRRSF  3905
PISTILLATA        AGACYRNWIDKFKGD-----PRNPSRFYGEMFKKANRTETERSFTQKQALVPWDLLRRAF  3932
HEMICHOR          -RLDHHTWVDKMVKHV--GDRTSHCVRYGELYKVASRTEILKKFQDLHTQVPWDALRRAF  3917
BELCHER           PLIDFDAYVHRLGGTV--K-NDPWGKVYGSLYQKASRTDVTLAFRQVQSKVTWDIMRRGY  3965
STRONG            PVALFTTWLQKFCQT---D-G-NITKLFTEAYKKANETETIKAFREREAKLPWDLLRRGF  3935
STARFISH          PRYQHSEWVDKYAKG---N-QSNHGVRYGAVYRHANYTDTVKCFRSWEALVPWDLMRRAF  3954
                                                                    :     ::
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Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

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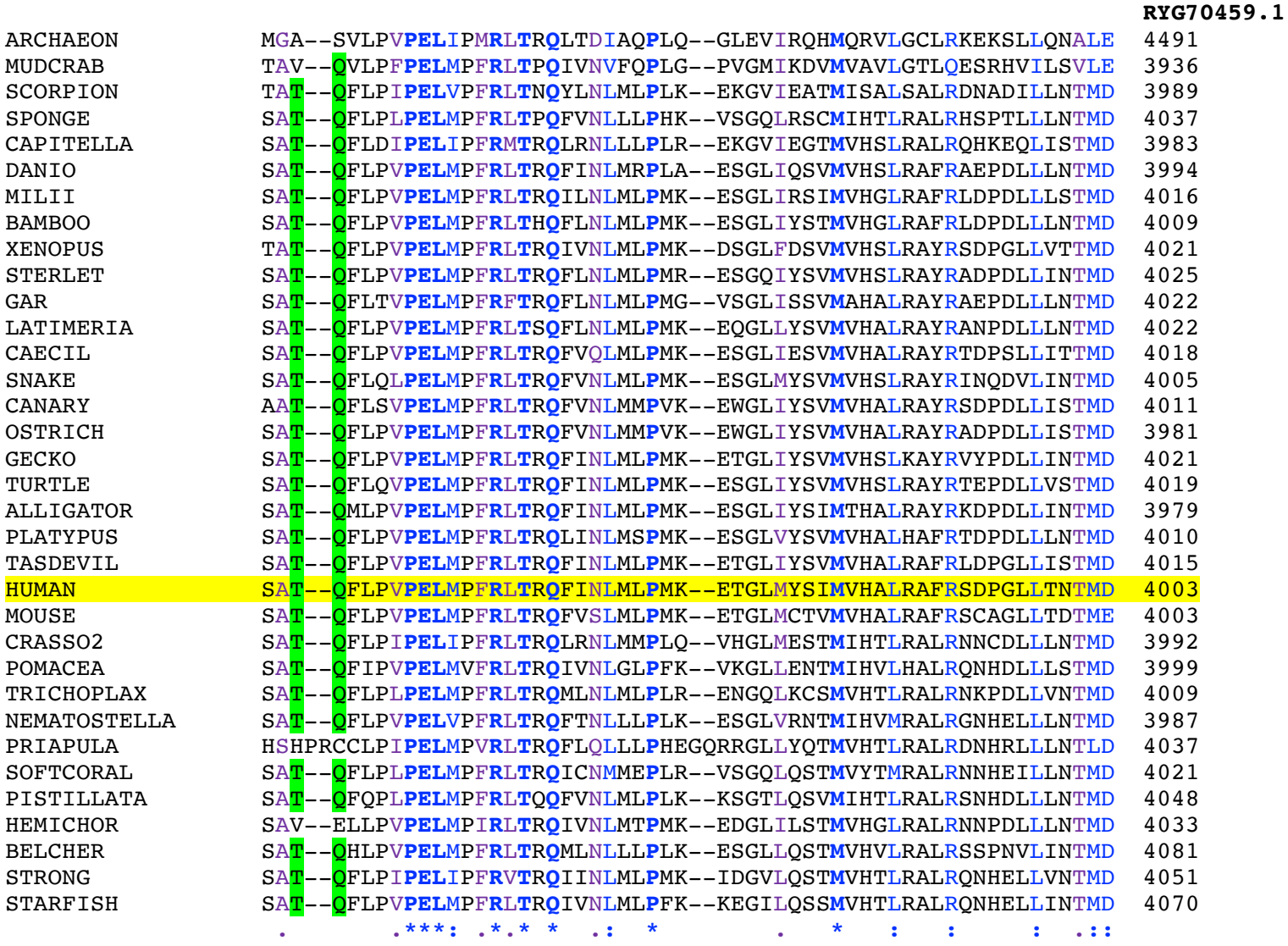
                                                                                                                  RYG70459.1
ARCHAEON          LSMSRNAETYYTLLHEFLASLSVNNIFGYILGIGDRHLENLLLDSSTGSIVNIDFGICFG  4435
MUDCRAB           VRLSSSSEGFFSLRSLFANSYATMCVSHWLLGIGDRHCGNTLVSLKTGRVVGIDFGHHFE  3880
SCORPION          LKFSSSLEAFVILRYNFITSHAVLCISQWLLGIGDRHTGNFLVSTTTGIEVGIDFGHAFG  3933
SPONGE            ISLASTSESFLLLRCTFIQSLSVINICQYILGIGDRHLSNFMVDMETGQLVGIDFGHAFH  3981
CAPITELLA         QKLASSPESYFVLRGNCATSHALNCISAYIMGIGDRHLSNHMVDLINGKMIAIDFGHAFG  3927
DANIO             VRMSTTPEAFLSLRSHFSSSHAVLCISHWILGIGDRHLSNFMINTETGGMIGIDFGHAFG  3938
MILII             IKMSTTPEAFLALRSHFASSHALMCISHWILGIGDRHLSNFMVNLETGGMVGIDFGHAFG  3960
BAMBOO            TKMSTTPEAFLALRSHFASSHALMCVSHWILGIGDRHLSNFMINLETGGMVGIDFGHAFG  3953
XENOPUS           VKMSTTPEAFLSLRSHFARSHALLCVSHWIVGIGDRHLSNFMINMETGGMIGIDFGHAFG  3965
STERLET           MKMSTTPEAFLSLRSHFTCSHALMCVSHWILGIGDRHLSNFMINMETGGMVGIDFGHAFG  3969
GAR               IQLSTTPESFLSLRSHFASTHALICVSHWILGIGDRHLSNFMVNMETGGMVGIDFGHAFG  3966
LATIMERIA         TKMSTSPEAFLTLRSHFASSHALMCISHWILGIGDRHLSNFMINMETGGMVGIDFGHAFG  3966
CAECIL            TKMSTTPEAFLTLRSHFASSHALICISHWILGIGDRHLSNFMINMETGGMVGIDFGHAFG  3962
SNAKE             VKMSTTPEALLSLRSHFASTHALLCISHWILGIGDRHLSNFMISTETGGLVGIDFGYAFG  3949
CANARY            VKMSTSPEAFLALRSHFASSHALMCISHWILGIGDRHLSNFMINKETGGMVGIDFGYAFG  3955
OSTRICH           VKMSTAPEAFLSLRSHFASSHALMCISHWILGIGDRHLSNFMINKETGGMVGIDFGHAFG  3925
GECKO             VKMSTTPEAFLSLRSHFASSHALMCISHWILGIGDRHLSNFMVNMETGGMVGIDFGHAFG  3965
TURTLE            VKMSTAPEAFLSLRSHFASSHALMCISHWILGIGDRHLSNFMINMETGGMVGIDFGHAFG  3963
ALLIGATOR         VKMSTAPEAFLSLRSHFTSSHALICISHWILGIGDRHLSNFMINTETGGIIGIDFGYAFG  3923
PLATYPUS          VKMSTRPEAFLALRSHFARSHALLCVSHWILGIGDRHLSNFMINLETGGMVGIDFGHAFG  3954
TASDEVIL          VKMSTTPEAFLALRSHFASSHALMCISHWILGIGDRHLSNFMINMETGGMIGIDFGHAFG  3959
HUMAN             VRMSTSPEAFLALRSHFASSHALICISHWILGIGDRHLNNFMVAMETGGVIGIDFGHAFG  3947
MOUSE             VKMSTSPEAFLALRSHFASSHALLCISHWLLGIGDRHLNNFMVAMETGSVIGIDFGHAFG  3947
CRASSO2           HKMSTSPEAFHVLRCKCASTHALISICQYVLGIGDRHLSNFMINLKNGEMVGIDFGHAFG  3936
POMACEA           QHLSTSPEAFHFLRCEMLTSHAVLCICHYLLGIGDRHLSNFMVNGRTGHMVGIDFGHAFG  3943
TRICHOPLAX        VALSASSEAYLMLRSHFARTHATVSICHYLLGIGDRHLSNFMIDRLTGGMIGIDFGHAFG  3953
NEMATOSTELLA      QQLAASPEAYLTLRTHFARTHACICICQYVLGIGDRHLSNFLVDMRTGGLIGIDFGHSFG  3931
PRIAPULA          LRLSASPEAFLALRTHFIKSHATLSVCHYVVGVGDRHLSNFMVSQEDGGMVGIDFGHAFG  3977
SOFTCORAL         MRLASSPEAFLTLRAYFARTYGCMTICHYILGIGDRHLSNSMVDLKQGRVIGIDFGHAFG  3965
PISTILLATA        LQLAVSPEAFFILRSHFASSHACLCICQYILGIGDRHLSNFLVDMETGGMIGIDFGHAFG  3992
HEMICHOR          QRLSSSPEAFLTLRGHFATSHALLCICQYILGIGDRHLSNFMISLDTGAMVGIDFGHAFG  3977
BELCHER           LQMSSCPEAFLTLRSHFTTTHATLCIAQYVLGIGDRHLGNFMIDLESGGMVGIDFGHAFG  4025
STRONG            MQLSASPEAFLTLRAHFARSHAVLCICQYILGIGDRHLSNFLVSLETGGMVGIDFGHSFG  3995
STARFISH          IQLSASPEAFLTLRSHFARSHAVICICQYILGIGDRHLSNFLISLKTGGMIGIDFGHAFG  4014
                    ::   *    *      : .   :  :::*:****  * ::    *  : ****  *
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"



Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                                  RYG70459.1
ARCHAEON          IYINDPLMDWMRGAAEALDREALLDQREQLLGGSFESSGTLPP------NNKEMSESVLW  4545
MUDCRAB           AFVKEPTEDWKEFVRELEG-------------------------------NLDESKIEM  3964
SCORPION          IFIKEPTVNWQENALKQKRIIGKVDEN-------VDSDINIYPGNTESDDPNHSECDFNW  4042
SPONGE            VFIKEPSLEWESNAKKQALAQ-----------------------------KINTDDNTW  4067
CAPITELLA         VFIKEPSLDWQNAAKKEIQAMSNR----------------------KEDTSKLTLDSQW  4020
DANIO             VFVKEPSLDWKNFELKQLKKGGTW------------------------TESVNTKEINW  4029
MILII             IFVKEPSLDWKNLELKQMKKGGTW------------------------NKDVNTREIHW  4051
BAMBOO            VFVKEPSLDWKNFELKQLKKEGSW------------------------SKDVNINEINW  4044
XENOPUS           VFIKEPSLDWKNLELKQMKKKGEW------------------------KKAVDVTSHNW  4056
STERLET           VFVKEPSLDWKNFELKQMKKAGSW------------------------SEAVNTNEINW  4060
GAR               VFVKEPSLDWKNFELKQLKKGGTW------------------------KETVNTKEIDW  4057
LATIMERIA         VFVKEPSLDWKNFELKQLKKGGSW------------------------TKEVNTKEVNW  4057
CAECIL            VFVKEPCLDWNNFMLKQLKKQGTW------------------------TKKVNTAEKNW  4053
SNAKE             IFVKEPSLDWKNFELKQLRKGGTW------------------------TKEINTDEVNW  4040
CANARY            VFVKEPSLDWKNFEQRQLKKGGTW------------------------IKEINTSEVNW  4046
OSTRICH           VFVKEPSLDWKNFEQRQLKKGGTW------------------------IQEINTSEVNW  4016
GECKO             IFVKEPSLDWKNFELKQLKKGGTW------------------------TKDINMDEVNW  4056
TURTLE            VFVKEPSLDWQNFELKQLKKGGTW------------------------SKEVNTAEINW  4054
ALLIGATOR         VFVKEPSLDWKNFELRLLKKGGTW------------------------LKEVNTCEVNW  4014
PLATYPUS          VFVKEPSLDWKNFETKMLKRGGTW------------------------TRAVNTADTNW  4045
TASDEVIL          VFVKEPSLDWKNFEQKMLKKGGSW------------------------TREVNMTEMNW  4050
HUMAN             VFVKEPSFDWKNFEQKMLKKGGSW------------------------IQEINVAEKNW  4038
MOUSE             IFVKEPSFDWKSFEQTMLRKGGSW------------------------IQEINVTEKNW  4038
CRASSO2           IFVKEPSVDWLVNAEKQMNEMKVE-----------------------VSPEDEVQW  4025
POMACEA           VFVKEVSLDWLQFAERQMRGGMGP-----------------------KDADEDMRW  4032
TRICHOPLAX        VFIKEPSLDWQNFANRQNAKQGL------------------------KTESDDFSW  4041
NEMATOSTELLA      VFVKEPSLDWQMFARKQAEDQHME-----------------------IGMYYEDLTW  4021
PRIAPULA          VFIKEPSIDWKATAERLADKDIHS----------------------NESDQGEQVQEW  4073
SOFTCORAL         VFVKEPSLDWQNFARKQAEKQKLN-----------------------LNDMTDLAW  4054
PISTILLATA        VFIQEPSLDWQVYARKQAKTQGIN-----------------------EEEQKADW  4080
HEMICHOR          VFVKEPHLDWQKRAKSDASKYGDA-----------------------AEDANEMIER  4067
BELCHER           VFIKEPHLDWKNFAAKQMDKG--------------------MVGEDDDLDDISW  4115
STRONG            VFVKEPSLDWKCFAVKQADYQKLS-----------------------EDSREDISW  4084
STARFISH          VFIKEPSLDWKTNASKQAKAQKDAGRV-------LEG----------QSDPDGNSLDESW  4113
                   ::::   :*
```

Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

```
                                                                                RYG70459.1
ARCHAEON          EPVRRVGGALRKLSGEDPLALLQEDLSNNVMVTR--MKSYDGLCRILGDVRRLLGAEAGG  4603
MUDCRAB           FSEERMRCLKEKLTGFNPAYVTVWALSKNKAVRR-DPTAFEELKKV----------VLG  4012
SCORPION          YPKQRILFAKRKLEGINPCYITKEELRLGHSNKP----IFQRLTDV----------CLG  4087
SPONGE            YPKEKVNICRKKLLGFNSSHLMLIDLEHGFKNKP----EFKYLKGI----------LLG  4112
CAPITELLA         FPKEKVNIVRQKLEGSNPSHVMRAELALGQLGS-----YLKYFVIV----------LMG  4064
DANIO             FPLQKVNFARRKLEGTNPSVITSEELCLGFEKMP----EYKGLLAV----------ARG  4074
MILII             YPMQKVRYARRKLEGANPAAITRDELQLGHETTE----AYKSYVAV----------AMG  4096
BAMBOO            YPRQKVNYAKRKLEGANPSAITRDELQLGHEKSK----AYASYVAV----------AMG  4089
XENOPUS           HPQQKIHCAKRKLDGANPCEITCEELRLGHESAP----EYKDFIAV----------ARG  4101
STERLET           YPMQKVNFARRKLEGANPAVITSEELKLGFEKSP----AYQSIIAV----------AQG  4105
GAR               YPRQKVQFAQRKLEGANPAAITSDELKLGFEKES----WCRAALAM----------AQG  4102
LATIMERIA         YPVQKVKCGRQKLEGVNPIVITCNELQLGHEKLS----AYQSYLAV----------VKG  4102
CAECIL            YAVQKVNCARRKLAGTNPAIITCDELELGHEKSV----AYKEMKAV----------AMG  4098
SNAKE             YPLQKVKIARRKLAGANPAVITCDELRLGHEKSE----AFREYVSV----------AQG  4085
CANARY            YPLQKVNYVRRKLTGANPAIITCDELRLGHERSP----AYNDFAAV----------ARG  4091
OSTRICH           YPLQKVSYVKRKLTGCNPGRITCDELRLGHEKSP----FFSDFVAV----------ARG  4061
GECKO             YPLQKVNFARRKLAGANPAVITSDELRLGHEKSS----AYRYYVSV----------ARG  4101
TURTLE            YPLQKVNCAKRKLAGANPAVLTCDELRLGHEKSP----AYKEYVAV----------AQG  4099
ALLIGATOR         YPLQKVNCVKRKLAGSNPAAITCEELRLGHEKSL----AYRDYVAV----------ARG  4059
PLATYPUS          YPLQKISYAKRKLTGTNPAIITCDELRLGHEKVP----AFGDYISV----------ARG  4090
TASDEVIL          YPLQKINYAKRKLAGANPAAITCDELHLGHEKVP----AFECYVSV----------AQG  4095
HUMAN             YPRQKICYAKRKLAGANPAVITCDELLLGHEKAP----AFRDYVAV----------ARG  4083
MOUSE             YPQHKIRYAKRKLAGANPAVITCDELYLGHEASS----AFRSYTAV----------ARG  4083
CRASSO2           YPKEKIEYVKRKLRGDNPVCISREELKLGHSKKP----AFPALERV----------LQG  4070
POMACEA           YPKQKIETAARKLKGDNPSYITRDELRIGHLRNQ----ALKDFEKV----------ALG  4077
TRICHOPLAX        YPREKVTFAKRKLKGANPAFVTRDELRLCHHL--------SILESF----------ALG  4082
NEMATOSTELLA      YPREKVLTAQRKLKGANPAFVTRQELELGHRRRS----WFRNLQSA----------CLG  4066
PRIAPULA          YPKQTIGVARSKLIGANPAHITKAELALGHRKHE----ALKQMTNV----------VLG  4118
SOFTCORAL         YPKEKINSAKRKLKGENPAEIMKQDLESGHKKAG----YYEEMLSV----------LLG  4099
PISTILLATA        YPKQKVQSAWRKLEGFNPAYVMRDDLQLGHSKQS----WYKQMESV----------CLG  4125
HEMICHOR          YAKDRINNARRKLQGANPCHITRDELKMNMNIKK---HYCTGYIDV----------CMG  4113
BELCHER           YPREKIKFAAKKLQGVNPTHITKAELQLGHKNLP----WFKSFCLV----------AMG  4160
STRONG            YPKKKIKFAKMKLQGVNSTYITKAELEMGPHSKDARDAPFLKALKS----------TCG  4133
STARFISH          YPREKVNFAQKKLEGANPSDITQRELALGHSRNP----AFSAIKEV----------VKG  4158
                       :     ** * :   :    *                                *
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Supplementary Figure 9: Clustal Omega: DNA-PKcs alignment metazoan plus "putative archaeon"

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                                                                End RYG70459.1 (Archaeon)
ARCHAEON            TNAGRTGKMKAAVELTVEEQVDALMAMATDPNVLVRQWVGLQAWL   4648
MUDCRAB             QNCESARANMDRTGLTIHQQVDILLEQATDPNILGRTWVGWSPFI   4057
SCORPION            DRK-SLRQNLPKNGLSVKQQVKSLIDQATDSGILSRIYFGWDPWF   4131
SPONGE              DSSTNLRARVGKRCDSVEDQVDCLIDHATDSNVLGRTYGGWEAWV   4157
CAPITELLA           DKQADIRARLPADGLSSEEQVAALLNLATDPNILGRTFAGWEPWV   4109
DANIO               EEQHNIRARLADKDLTVEDQVDCLLDQATDPNILGRVWIGWEPWI   4119
MILII               DKEHNIRARVPEDGLSVEIQVDCLIDQATDPNILGRVWEGWEPWM   4141
BAMBOO              DKDHNVRARESEEGLSVECQVDCLIDQATDPNILGRVWIGWEAWM   4134
XENOPUS             DKKHNRRTNEPPDGLTEETQVQCLIDQATDPNILGRVWKGWEPWI   4146
STERLET             EKEHNVRAREAPQGLSVETQVECLIDQATDPNILGRVWVGWESWV   4150
GAR                 EQGVNVRASQAAEGLAVEIQVECLLDQATDPNILGRVYMGWEPWI   4147
LATIMERIA           DPDHNVRAREVKEDLPVETQVACLIDQATDPNILGRVWEGWEPWM   4147
CAECIL              DKTHNVRAREPKDGLTEEIQVKCLLDQATDPNILGRVWEGWEPWM   4143
SNAKE               SKQFNIRARQPQDGLAEEIQVKCLIDQATDPNILGRTWEGWEPWM   4130
CANARY              NSNHDIRAKEPEDGLSEETQVRCLIDQATDPNILGRVWEGWEPWM   4136
OSTRICH             NAAHNTRAKEPEDGLSEETQVKCLIDQATDPNILGRAWEGWEPWM   4106
GECKO               SKEHNIRAKEAEDGLSEEIQVKCLIDQATDSNILGRVWEGWEPWM   4146
TURTLE              SRDHNIRAKEPEDGLSEEIQVRCLLDQATDPNLLGRVWEGWEPWM   4144
ALLIGATOR           TRDQNIRAKEPEDGLTEETQVKCLIDQATDPNILGRVWAGWESWM   4104
PLATYPUS            SKDHNVRARQPEEGLSEEQQVQCLIDQATDPNILGRTWIGWEPWM   4135
TASDEVIL            NRDHNFRAQQPDDGLSEETQVKCLMDQATDPNVLGRTWIGWEPWM   4140
HUMAN               SKDHNIRAQEPESGLSEETQVKCLMDQATDPNILGRTWEGWEPWM   4128
MOUSE               NRDYNIRAQEPESGLSEETQVKCLVDQATDPNILGRTWEGWEPWM   4128
CRASSO2             DKRENVRAQLPASGLTVEQQVAALIDQATDPNIVGRVWGGWEPWM   4115
POMACEA             DVQDNIRARLKEKGLTEEQQVAALIDQATDPNILGRAWGGWEPWL   4122
TRICHOPLAX          DKQYNERARMPADNLSVEDQVTCLIDQATDPNILGRTWQGWEPWM   4127
NEMATOSTELLA        DRRHNVRAQKEENELTSEAQVDCLIDQATDVNILGRAWEGWEAWV   4111
PRIAPULA            DPRSDLRAQLPPEGLTVEQQVQCIIEQATEPSLLGRTWVGWEPWM   4163
SOFTCORAL           DKQHNQRARHYV--NTVENQVACLIDQATDPNILGRTYHGWEPWV   4142
PISTILLATA          DRNANVRAREPESGLSVESQVSCLIDQATDANILGRTWQGWEPWV   4170
HEMICHOR            DKKYSMRTREPATGLSVEKQVACLVDQAIDPNILGRAYEGWEAWV   4158
BELCHER             DGGKDVRAQKPAEGLSVEDQVACLIDQATDPNILGRTWQGWQSFM   4205
STRONG              GNTESKRAQSKSKGLSVEDQVACLIDQATDPRILGKTYQGWEPWV   4178
STARFISH            DRSQNIRASSPKSGLSVETQVECLIDQATDPNILGRVYAGWEAWM   4203
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