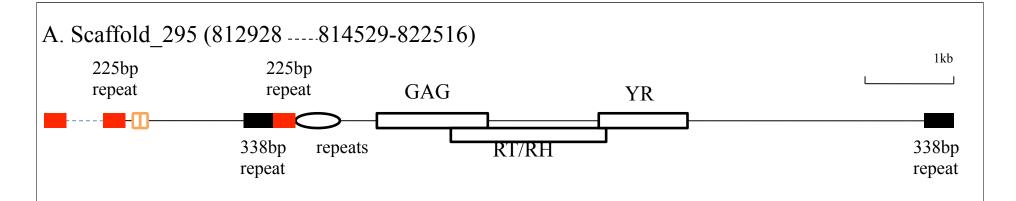**Additional file 9.** Genomic organization of the tyrosine recombinase domain-encoding retroelement found adjacent to the VCBP2/5 gene cluster. A. The gene consists of three main open reading frames, GAG-like, RT/RH –like, and tyrosine recombinase –like, on alternate reading frames. The gene is flanked by direct repeats (rectangles); duplication of direct repeats (red) are found upstream. B. Amino acid sequence homology with a Ngaro retrotransposon from *Lytechinus variegates* (green sea urchin); separated by domain.

A. Scaffold_295 (812928 ----814529-822516)

225bp repeat   225bp repeat   GAG   YR   1kb

338bp repeat   repeats   RT/RH   338bp repeat

B. Comparison of amino acid sequence with green sea urchin (*Lytechinus variegates*) Ngaro1

GAG

```
295_GAG          MPPTRRSKRNRKPKNANPDDPTEKEPPVDPNKDPKDPPPNVSE————REQLKQLQQ
Lv_GAG_DAA01766.1 -MPKVKAKKITTAGARKGDDTPKRRPGRPRGPRATSTPASVDLGLGGGNNGPGRSGELNP
                     * *::  **  ::**..::* ..  .     .  .**.*  :

295_GAG          QVSALTSVTERLAKHIESSGSHSEQPDPSLPPAVLDPRHSKDTLVDRIIGEENDLFVVKT
Lv_GAG_DAA01766.1 SQSQVVDVDEKSGRPRSKVSDKMAELDLDLVGREGQAPVGRSIAWHEIVAQESDTGSSGQ
                   . * ::.**.:  .  ..  .   .  .:. .   :.      *:*.*

295_GAG          TDNINRSKDKDK————ITSETTNKTIPPAP——TTTTSHLQTGIHVPLDSGVPT
Lv_GAG_DAA01766.1 AQPAVSVPARSAGVAEDLGLDLVEVGVERSEPQAPRLSAVLGAPEPFSSACDPLGVEVAI
                   ::.  :  .    :*    .   ** .:.   .      .   **. *.

295_GAG          HIKDKIWSNKYVDFKQLLPN-LCTDPLYTVSLTDSLT———PTLTIANRPSPQESRRL
Lv_GAG_DAA01766.1 SLKEKIWASEYIDLGVLLKHNARDEFGALSVGDTTLSLCQSGSGLGLQLGPQGSKAKKIM
                   .:*::**:.*: *:.. **.  . :       . :    . *** :.* :

295_GAG          TIDQWTSAFLVFQFIYMQQHPQHGPHLVSYLHLIRDLASRRA—QWGKYDEQFRHHRETS
Lv_GAG_DAA01766.1 SVEQWTSVFLVFASIYAEKHIERSRELMKYMDLIRHAARAFAGYGWRDYDTQFRSKQARL
                   ::::****. **** :**  :: .  **.  ** :.:  . *  *.:

295_GAG          PDTPWNTPHLQLYVDALTGIPPPDQAAAPQTS————APTRRADTHQTRPQTRPKDV
Lv_GAG_DAA01766.1 PGRSWASVDAELWLMLVASNGPRQRHNLPHAPRHQFYRGEYGARKSFPFGGKGPGANGTP
                   * .   *: *:  . :: . *      **    . .:::  .  :

295_GAG          PHGYCFRFHRPDDQCFK-ALCPYNHTCYICNSGKHKAYQCTQKTAANATNSRRR
Lv_GAG_DAA01766.1 SRGVCFAFNR—GKCMRGKACIYEHKCSRCQATGHGAKQCSQGRAGSSPAGSK-
                   .:* ** **: .:  .  ***:* **:* * ** **..*  .:  ::
```

RT/RH

```
295_RT/RH          LAFPLQIR————PRPPRPAPRPAGLTHTRPGPR————PDPKMSPTGTVFASTGPMTSV
Lv_YR_DAA01767.2   CWWPLMVRGSATIYPMPLAISSTEGSTARENLFPSEERDPEPMAHPAEACALPLIEASAC
                   :** :*  * .     ** *. . :.:  *: .*

295_RT/RH          SKPSAPTTTHAISATVESTKLTNAPKKPPR————————TLPTPVDVRPLQYY
Lv_YR_DAA01767.2   EAKLASMSTSVPAARRQVMGLSSVAKGGPVPVPLAVNRSTASAVSSIAPTPIKLARLVPM
                   . *  :*.:* *  . .  *:  **.

295_RT/RH          LRGYP-QRDKQYLLDGVFGFPLEYFGPRSRPLIFPPQPNDSHFPIIHDKLQQEIEAGRV
Lv_YR_DAA01767.2   LATYPNGEHAQCLYNGFKFGFSLHFEGDRVPLVVKNLKSAFEHMDALKKKLRDEIDLGRI
                   *  **  ::  : *.:: *** :** .:  **.   .   **..**.:: * **

295_RT/RH          AGPFSSPPYNNLFLSPLYAVPKKVPGKFRLIHDLSHPKGLSVNDGIPPELSSVTYSSIDT
Lv_YR_DAA01767.2   VGPFVVPPFENMRCSPVGLVPKKAPGEFRMIQHLSAPRGNSVNDGIPEGQCTVTYSSFDS
                   .**** **: *:   **: ***** **:**:  ** *:* .****** .. ****.*

295_RT/RH          AIGYIKSLGPGCYLAKTDIESAFRLIPIHPHDYHLLGFYWNGNFYFDKCLPMGSSMSCAI
Lv_YR_DAA01767.2   AVDIVTQLGRGALMGKTDIKSAFRLLPVHPKDFELLGMYIDGRYYFDRCLPMGCAVSCST
                   *:. :  **.* *:**** ****** *:**:*: ** *   . ****.****** *.**

295_RT/RH          FESFSSALEWIARTKLHIRFPTHILDDFLFAA-KTYRQCYHDLNTFSNMCKDVGVPLAEG
Lv_YR_DAA01767.2   FECFSTFLEFCARKVAKSQNIVHYLDOFFFAGGPASEDCRRAMHCFEAICERFGVPIARE
                   **.** : *:  ** :    * :*.* :** :   .:*     * * :  .:***:

295_RT/RH          KTYTPDTTMSFLGIELDTVVMEARLPLDKLTKCQDQLSSFLGLSSATLKQIQSLVGLLNH
Lv_YR_DAA01767.2   KTEGPTTQLSYLGLVIDSVSQQVRVPEDKIEKLVGKLNWAVQKQKISLRDIQSIVGSLNF
                   ** * * :**:  :*:* * .  *:* **: ** **:*.* :* : *.:***:**.**.

295_RT/RH          VCQVVPPGRAFLRRLIDLTKSQSPPNCNIPIPQHVRRDLHMWYTFLKDFNGRSFFLDERF
Lv_YR_DAA01767.2   VCKAIAPGRAFMRRLIDLTKSVKRPFHMVRLTRGAKADLRVWLEFLAHFNGQVFFRAPGW
                   **:.: *****:******** . *   : : .  :: ** .* :**. ***: .**

295_RT/RH          ISNSTLHLYTDAAASLGYGAVCGTAWFYGSWPTSLCS—RNITILEFYPIVVALHVWGQP
Lv_YR_DAA01767.2   FGSEEIQFFTDAAAGIGFGIFFGGRWAQSRWPADFQADRRSIAFLELFPIWVGLEIWGME
                   :...: *:*.****.:*:* * * .*  * **:*:  .  **. :***:** * :.**

295_RT/RH          WANHSILLHTDNESLVHIINRQTSKNPLIMPLVRRFVLICLRRNILYRATHVPGKQNIMA
Lv_YR_DAA01767.2   LKDKNILFNCDNQAVVAVLNKQSALCPDIMVLVRKVVIICLSNNIVLRARHVHGCDNGIA
                   ::.**:: .:**::.*.::*:*:*  **:*.****:**::*** ** ** :** * :**.*

295_RT/RH          DTLSRLQINRFQADFQHMDPHPTTIPPHLQPNTLIGP——
Lv_YR_DAA01767.2   DALSRFQMPRFHALAPGAAREGVEVPVRLWKSWLSREVDC
                   *:***:*: **:**  .   .   . :* :* .*
```

YR

```
295_YR            PWQTKHNGHSLPPTDQPIPSGLPTYGPSSDNYTATPATEHLNRTINDLLSSSLAPSTLRA
Lv_YR_DAA01768.3  ————————CTISISDAEVP-CVSTGGRPGGRGGSSPSLEELAIERSRLLMSRAARTHTT
                                     :::  :*  :*  :.*.*..  :**:** :  .** **.:   .

295_YR            YRQAWQLFRKFSLQVHGKDLAIPPISTDLLTQFVGYLYNEGLAAATISSKLSAIGFVHKM
Lv_YR_DAA01768.3  YSIALGAYVKF-CKVYGYDPQLPPN-VEWVAQFISYLSFMGYAGSTIQTYISGLAFYMSS
                   *  * :  :** : :* :*   **  *: *.**  . .:  :*:..**  : ** *.:.

295_YR            LGIPDPSQAFVIQKLLHAARKS-QRPDGRRPITPSILKTLIDALTSALPSFYDHQLYKTL
Lv_YR_DAA01768.3  SGLKDVTKSFVITRLIEGCRRSTLRRDARHPITLSVLNRMLAYLRHVCGSHYDVLMYSAA
                   *: *  :.***: :*:. .*:* ::* .*:*** *:*:.:: * *.  .:**.:: :

295_YR            FLFTFYSLARISEVTATSSSNHTLHLSDVTVQTT——PQPSLSVTFRSYKHSSPGLPPTI
Lv_YR_DAA01768.3  FSVAFYGLLRVSELTVESRHRCESILQHTDVRVTGDAPHRRVELFLRKSKTDQRGNGCTI
                   * .:**.* *:**:*. *..   . * *: * * .   * * . :: ** *:    .* **

295_YR            SIASQPGSSYCPVDNFTKYLSLRGKCAGCLFLYRSGRPVSSDYFSHVLRTCAQHANLDPR
Lv_YR_DAA01768.3  SIP-ELGTVSCPVMAVIRYLEIRPKNGGAFFCSYGALPLTRREFGNMIKRCLTYGDMPAA
                   **. :**. ****:.. ::**.:*.*   ..** .  *::   * .:::*  * :  .* *

295_YR            AYTAHSFRIGAATYAAQTGASDSQLRALGRWSSGAFKKYIRS——
Lv_YR_DAA01768.3  MFSSHSFRIGAATTAAMAGCSDEEIQRMGRWVSSAHRRYIRLDMVK
                   ::.*********  ** :* :**::::* ***.*.*::*** . :
```