

1 **A neuropeptide modulates sensory perception**
2 **in the entomopathogenic nematode**
3 ***Steinernema carpocapsae***

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14 Sensory perception; Nictation; Dispersal; Jumping; SPME GC-MS

15
16 **Abstract**
17 Entomopathogenic nematodes (EPNs) employ a sophisticated chemosensory apparatus to
18 detect potential hosts. Understanding the molecular basis of relevant host-finding behaviours
19 could facilitate improved EPN biocontrol approaches, and could lend insight to similar
20 behaviours in economically important mammalian parasites. FMRFamide-like peptides are
21 enriched and conserved across the Phylum Nematoda, and have been linked with motor and
22 sensory function, including dispersal and aggregating behaviours in the free living nematode
23 *Caenorhabditis elegans*. The RNA interference (RNAi) pathway of *Steinernema*

24 *carpocapsae* was characterised *in silico*, and employed to knockdown the expression of the
25 FMRFamide-like protein 21 (GLGPRPLRFamide) gene (*flp-21*) in *S. carpocapsae* infective
26 juveniles; a first instance of RNAi in this genus, and a first in an infective juvenile of any EPN
27 species. Our data show that 5 mg/ml dsRNA and 50 mM serotonin triggers statistically
28 significant *fip-21* knockdown (-84%***) over a 48 h timecourse, which inhibits host-finding
29 (chemosensory), dispersal, hyperactive nictation and jumping behaviours. However, whilst 1
30 mg/ml dsRNA and 50 mM serotonin also triggers statistically significant *fip-21* knockdown (-
31 51%**) over a 48 h timecourse, it does not trigger the null sensory phenotypes; statistically
32 significant target knockdown can still lead to false negative results, necessitating appropriate
33 experimental design. SPME GC-MS volatile profiles of two EPN hosts, *Galleria mellonella*
34 and *Tenebrio molitor* reveal an array of shared and unique compounds; these differences
35 had no impact on null *fip-21* RNAi phenotypes for the behaviours assayed. Localisation of
36 *fip-21* / FLP-21 to paired anterior neurons by whole mount *in situ* hybridisation and
37 immunocytochemistry corroborates the RNAi data, further suggesting a role in sensory
38 modulation. These data can underpin efforts to study these behaviours in other
39 economically important parasites, and could facilitate molecular approaches to EPN strain
40 improvement for biocontrol.

41

42 **Author summary**

43 Entomopathogenic nematodes (EPNs) use a range of behaviours in order to find a suitable
44 host, some of which are shared with important mammalian parasites. The ethical burden of
45 conducting research on parasites which require a mammalian host has driven a move
46 towards appropriate ‘model’ parasites, like EPNs, which have short life cycles, can be
47 cultured in insects or agar plates, and have excellent genomic resources. This study aimed
48 to develop a method for triggering gene knockdown by RNA interference, a biochemical
49 pathway involved in gene regulation. Through knocking down the expression of a target
50 gene we can then study the function of that gene, helping us to understand the molecular

51 basis of behaviour. Here we have characterised the RNAi pathway of *Steinernema*
52 *carpocapsae* through analysing the genome sequence for relevant genes, and have
53 successfully knocked down the neuropeptide gene *fip-21* in *S. carpocapsae* infective
54 juveniles. We find that it is involved in the regulation of behaviours which rely on sensory
55 perception and relate to host-finding. We have localised the gene and mature neuropeptide,
56 and find them to be expressed in paired anterior neurons, which is in broad agreement with
57 our behavioural observations following RNAi. Our observations are relevant to interactions
58 of *S. carpocapsae* with two insect hosts, the waxworm *Galleria mellonella*, and the
59 mealworm, *Tenebrio molitor*. We identified the volatile compounds relating to both insects,
60 and find that there are both shared and unique compounds to both species; EPNs use
61 volatile compound gradients, as well as other physical cues in order to find and invade a
62 host. This study provides a method for employing RNAi in a promising model parasite, and
63 characterises the molecular basis of host-finding behaviours which could be relevant to
64 economically important mammalian parasites. EPNs are also used as bioinsecticides, and
65 so understanding their behaviour and biology could have broad benefits across industry and
66 academia.

67

68 **Introduction**

69 Entomopathogenic nematodes (EPNs) borrow their name from the entomopathogenic
70 bacteria (*Photorhabdus*, *Serratia* and *Xenorhabdus* spp.) with which they form a commensal
71 relationship. These nematodes provide a stable environment for the bacteria, and act as a
72 vector between insect hosts. Once the nematode has invaded an insect, the nematode
73 exsheathes (or ‘recovers’) and entomopathogenic bacteria are regurgitated into the insect
74 haemolymph; the bacteria then rapidly kill and metabolise the insect, providing nutrition and
75 developmental cues for the nematode. These entomopathogenic bacteria are then
76 transmitted between nematode generations (1). The entomopathogenic lifestyle has been
77 found to arise independently in nematodes, at least three times, spanning significant

78 phylogenetic diversity. *Heterorhabditis* and *Oscheius* spp. (2) reside within clade 9 along
79 with major strongylid parasites of man and animal (3); *Steinernema* spp. reside within clade
80 10 alongside strongyloidid parasites (4).

81
82 Nictation is a dispersal and host-finding strategy, enacted by nematodes which stand upright
83 on their tails, waving their anterior in the air (5). This behaviour is shared amongst many
84 economically important animal parasitic and entomopathogenic nematodes, alongside the
85 model nematode *C. elegans*, for which nictation is a phoretic dispersal behaviour of dauer
86 larvae, used to increase the likelihood of attachment to passing animals. Nictation is
87 regulated by amphidial IL2 neurons in *C. elegans*, which occur in lateral triplets either side of
88 the pharyngeal metacorpus (5, 6). IL2 neurons display significant remodelling from *C.*
89 *elegans* L3 to dauer (the only life-stage to enact nictation behaviours) such that connectivity
90 with other chemosensory and cephalic neurons is enhanced (6). It has been shown that IL2
91 neurons express the DES-2 acetylcholine receptor subunit, and that cholinergic signalling is
92 requisite for nictation (5, 7-9). Additionally, the central pair of IL2 neurons express the
93 FMRFamide-like peptide (FLP) receptor, NPR-1 (10). To date there are two known NPR-1
94 agonists; FLP-18 and FLP-21 (11). However, there is also known redundancy of FLP-18
95 and FLP-21 in signalling through other neuropeptide receptors (NPR-4, -5, -6 -10, -11, and
96 NPR-2, -3, -5, -6, 11, respectively) in heterologous systems (12, 13), making functional
97 linkage difficult. *Steinernema* spp. also display a highly specialised jumping behaviour which
98 is thought to enhance both dispersal and host attachment. Jumping occurs when a nictating
99 infective juvenile (IJ) unilaterally contracts body wall muscles bringing the anterior region
100 towards the posterior region, forming a loop. This generates high pressure within the IJ
101 pseudocoel, and differential stretching and compression forces across the nematode cuticle.
102 Release of this unilateral contraction, in conjunction with the correction of cuticle pressure,
103 triggers enough momentum for an IJ to jump a distance of nine times body length, to a
104 height of seven times body length (14). Here we aimed to study the function of *Sc-flp-21* in
105 coordinating nictation and other behaviours relevant to host-finding.

106

107 The recent publication of five *Steinernema* spp. genomes, along with stage-specific
108 transcriptomes (15) represents a valuable resource, alongside the previously published
109 genomes of *Oscheius* sp. TEL-2014 (16) and *Heterorhabditis bacteriophora* (17). The
110 genome of *Steinernema carpocapsae* is the most complete, at an estimated 85.6 Mb, with
111 predicted coverage of 98% (15). *S. carpocapsae* was selected as a test subject for our
112 study due to the quality of genome sequence. The close phylogenetic relationship between
113 *Steinernema* spp. coupled with a diverse behavioural repertoire, particularly in terms of host-
114 finding (18, 19), make this genus an extremely attractive model for comparative
115 neurobiology. The aim of this study was to examine RNAi functionality in *S. carpocapsae*
116 IJs, and to probe the involvement of FLP-21 in coordinating sensory perception (host-finding,
117 nictation, jumping and dispersal phenotypes), as a prelim to probing the neuronal and
118 molecular underpinnings of host-finding behaviour in this genus.

119

120 Materials and Methods

121 ***S. carpocapsae* culture**

122 *S. carpocapsae* (ALL) was maintained in *Galleria mellonella* at 23°C. IJs were collected by
123 White trap (20) in a solution of Phosphate Buffered Saline (PBS). Freshly emerged IJs were
124 used for each experiment.

125

126 **BLAST analysis of *S. carpocapsae* RNAi pathway**

127 BLAST analysis of RNAi pathway components was conducted as in Dalzell et al. (21), using
128 a modified list of core RNAi pathway components from *C. elegans*, against predicted protein
129 sets and contigs of the *S. carpocapsae* genome, through the Wormbase Parasite BLAST
130 server (22, 23).

131

132

133 **dsRNA synthesis**

134 *Sc-flp-21* (Gene ID: L596_g19959.t1) dsRNA templates were generated from *S.*
135 *carpocapsae* IJ cDNA using gene-specific primers with T7 recognition sites (see Table 1).
136 Neomycin phosphotransferase (*neo*) and Green Fluorescent Protein (*gfp*) dsRNA templates
137 were generated from pEGFP-N1 (GenBank: U55762.1). Template PCR products were
138 generated as follows: [95 °C x 10 min, 40 x (95 °C x 30 s, 60 °C x 30 s, 72 °C x 30 s) 72 °C x
139 10 min]. PCR products were assessed by gel electrophoresis, and cleaned using the
140 Chargeswitch PCR clean-up kit (Life Technologies). dsRNA was synthesised using the T7
141 RiboMAX™ Express Large Scale RNA Production System (Promega), and quantified by a
142 Nanodrop 1000 spectrophotometer.

143

144 **RNAi**

145 1000 *S. carpocapsae* were incubated in 50 µl PBS with dsRNA and 50 mM serotonin across
146 four experimental regimes; (i) 24 h in 5 mg/ml dsRNA / serotonin / PBS; (ii) 24 h in 5 mg/ml
147 dsRNA / serotonin / PBS, followed by washes to remove the initial dsRNA, and 24 h
148 recovery in PBS only; (iii) 48 h in 5 mg/ml dsRNA / serotonin / PBS; and (iv) 48 h in 1 mg/ml
149 dsRNA and serotonin. Each experiment was conducted at 23 °C. We found that 50 mM
150 serotonin induced oral uptake of fluorescent dyes under all conditions tested; 50 mM
151 octopamine did not (data not shown).

152

153 **RNA extraction, cDNA synthesis and quantitative (q)RT-PCR**

154 Total RNA was extracted from 1000 IJs using the Simply RNA extraction kit (Promega, UK)
155 and Maxwell 16 extraction system (Promega, UK). cDNA was synthesised using the High
156 Capacity RNA to cDNA kit (Applied Biosystems, UK). Each individual qRT-PCR reaction
157 comprised 5 µl Faststart SYBR Green mastermix (Roche Applied Science), 1 µl each of the
158 forward and reverse primers (10 µM), 1 µl water, 2 µl cDNA. PCR reactions were conducted
159 in triplicate for each individual cDNA using a Rotorgene Q thermal cycler under the following
160 conditions: [95 °C x 10 min, 40 x (95 °C x 20 s, 60 °C x 20 s, 72 °C x 20 s) 72 °C x 10 min].

161 Primer sets were optimised for working concentration, annealing temperature and analysed
162 by dissociation curve for contamination or non-specific amplification by primer–dimer as
163 standard. The PCR efficiency of each specific amplicon was calculated using the Rotorgene
164 Q software. Relative quantification of target transcript relative to two endogenous control
165 genes (*Sc-act* and *Sc-β-tubulin*) was calculated by the augmented $\Delta\Delta Ct$ method (24),
166 relative to the geometric mean of endogenous references (25). One way ANOVA and
167 Fisher's LSD test were used to analyse data (GraphPad Prism 6). The most similar non-
168 target gene (*L596_g5821.t1*) was identified using BLASTn against the *S. cariocapsae*
169 genomic contigs (supplemental figure S1), and primers *Sc-L596_g5821.t1-f* and *Sc-*
170 *L596_g5821.t1-r* were used to assess transcript abundance relative to *Sc-act* across control
171 and experimental conditions for the 48h dsRNA exposure experiments only (Table 1).

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189 **Table 1.** dsRNA synthesis and qRT-PCR primer sequences.

Primer designation	Sequence (5' – 3')
Sc-flp-21-F	TTCTGAGCCGCTATCTGAGC
Sc-flp-21-Ft7	TAATACGACTCACTATAAGTTCTGAGCCGCTATCTGAGC
Sc-flp-21-R	AGTCGCAGGGAACAAACAAT
Sc-flp-21-Rt7	TAATACGACTCACTATAAGGAGTCGCAGGGAACAAACAAT
neo-F	GGTGGAGAGGCTATTGGCTA
neo-Ft7	TAATACGACTCACTATAAGGGTGGAGAGGCTATTGGCTA
neo-R	CCTTCCCCTTCAGTGACAA
neo-Rt7	TAATACGACTCACTATAAGCCTCCGCTTCAGTGACAA
gfp-F	GGCATCGACTTCAAGGAGGA
gfp-Ft7	TAATACGACTCACTATAAGGGCATCGACTTCAAGGAGGA
gfp-R	GTAGTGGTTGTCGGGCAGCA
gfp-Rt7	TAATACGACTCACTATAAGGTAGTGGTTGTCGGGCAGCA
Sc-act-Fq	ATGTTCCAGCCCTTTCC
Sc-act-Rq	GATGTCGCACTTCATGATCG
Sc-βtub-Fq	CTCGGAGGAGGAGATGACAG
Sc-βtub-Rq	ATCATAACGGCACGAGGAAC
Sc-flp-21-Fq	GCTGCCTTCCTCGTACTCTTC
Sc-flp-21-Rq	TCAGATAGCGGCTCAGAAC
Sc-L596_g5821.t1-Fq	GTGGGAAATCCGACACAAA
Sc-L596_g5821.t1-Rq	GTCACGTCGTCCACTATAAAC

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195 **Headspace Solid-Phase MicroExtraction (SPME) GC-MS**

196 Approximately 5 g of fresh waxworm (*Galleria mellonella*) and mealworm (*Tenebrio molitor*)
197 larvae were placed into 20 mL glass tubes and sealed. The holder needle was exposed to
198 the headspace of the tube over a 120 min timecourse (extraction time) at room temperature
199 (22 °C). After this time, the SPME syringe was directly desorbed in the GC injection port for
200 5 min. A fused silica fibre coated with a 95 µm layer of carboxen–polydimethylsiloxane
201 (CAR–PDMS; Supelco) was used to extract the volatile compounds from the samples.
202 Fibres were immediately thermally desorbed in the GC injector for 5 min (with this time we
203 desorb the analytes and re-activated the fiber for the next analysis) at 250 °C and the
204 compounds were analysed by GC-MS.

205

206 A CTC Analytics CombiPal autosampler was coupled to a 7890N Agilent gas chromatograph
207 (Agilent, Palo Alto, California) and connected to a 5975C MSD mass spectrometer. The
208 manual SPME holder (Supelco, Bellefonte, PA, USA) was used to perform the experiments.
209 Chromatographic separation was carried out on 30 m x 0.25 mm I.D. ZB-semivolatiles,
210 Zebron column (Phenomenex, Macclesfield, UK).The oven temperature was set at 40 °C
211 for 3 min, temperature increased from 40 to 250 °C at 5 °C min⁻¹ and set at the maximum
212 temperature for 4 min. Helium was used as carrier gas at 1 ml min⁻¹. Mass spectra were
213 recorded in electron impact (EI) mode at 70 eV. Scan mode was used for the acquisition to
214 get all the volatile compounds sampled. Quadrupole and source temperature were set at 150
215 and 230 °C respectively. Compounds were identified using MS data from the NIST library
216 (>95% confidence).

217

218 **Dispersal assays**

219 100 *S. cariocapsae* IJs were placed in the centre of a 90 mm PBS agar plate (1.5 % w/v) in
220 a 5 µl aliquot of PBS. Plates were divided into four zones; a central zone 15 mm in
221 diameter, and three further zones equally spaced over the remainder of the plate. Plates
222 were allowed to air dry for ~5 min. Evaporation of the PBS allowed the IJs to begin

223 movement over the agar surface. Lids were then placed back onto the Petri dishes, and
224 plates were incubated at 23 °C in darkness for one hour. IJs were counted across central
225 and peripheral zones and expressed as percentage of total worms. Our subsequent
226 analysis was conducted on total IJs found within the two central zones. Relative to those
227 found in the two peripheral zones.

228

229 **Nictation & jumping assays**

230 3.5 g of compost (John Innes No.2) was placed in a petri dish (55 mm), and dampened
231 evenly with 150 µl PBS. Approximately ten IJs were pipetted onto the compost in 5 µl of
232 PBS, and left for 5 minutes at room temperature; this enabled IJs to begin nictating. For the
233 waxworm volatile challenge, one healthy waxworm (UK Waxworms Ltd.) was placed inside a
234 1 mL pipette tip, without filter. For the mealworm volatile challenge, two mealworms
235 (Monkfield Nutrition, UK), weight-matched to the waxworm, were placed inside a 1 mL
236 pipette tip, without filter. Blank exposure data were captured using an empty 1 ml pipette tip,
237 without filter. In each case, the pipette was set to eject a volume of 500 µL, comprising air
238 and the corresponding insect volatiles. A binocular microscope was used to record IJ
239 behavioural responses following up to five volatile exposures each, on gentle ejection from
240 the pipette within a distance of ~1 cm of the *S. carpocapsae* IJs. A five second period was
241 allowed between each volatile exposure. Recording ended for any individual when jumping
242 was observed or the IJ abandoned a nictating stance (this always corresponded with
243 migration away from the stimulus). A jumping index was calculated for each treatment group
244 (1). Additional behavioural observations were recorded, and subsequently reported as
245 percentage IJs displaying the behaviour over the course of up to five volatile exposures, or
246 until the IJ migrated / jumped out of the field of vision.

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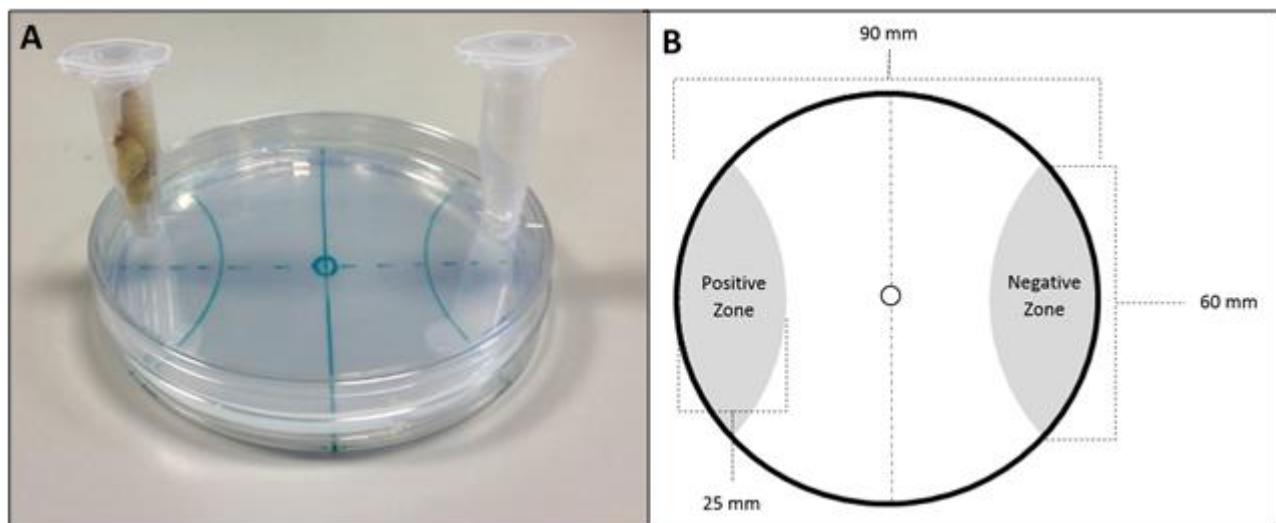
250

251 **Host finding assay**

252 Two circular holes (approx. 6 mm diameter, centred 4 mm from edge of lid) were drilled
253 either side of a 90 mm petri dish lid. Two microcentrifuge tubes (1.5 ml) with a small hole cut
254 out the bottom (approx. 2mm diameter), were also used for each assay. 200 *S. carpocapsae*
255 IJs were placed in the centre of a 90 mm PBS agar plate (1.5 % w/v) in a 5 μ l aliquot of PBS.
256 The arena was segmented into positive and a negative zones either side of the plate (25 mm
257 in length from the edge, circling off the plate at a point 60 mm apart; see Fig XA). Plates
258 were allowed to air dry for ~5 min, allowing the IJs to begin migration. The lid was placed on
259 top of the plate, and sealed with parafilm. The 1.5 ml tubes were secured in the holes with
260 parafilm; one remained empty, which we term the blank tube, and the other held four live
261 *Galleria mellonella* fourth instar larvae, or four *Tenebrio molitor* larvae as appropriate. The lid
262 of the tubes were then closed. The plates were incubated at 23 °C in darkness for one hour.
263 IJs were counted in the positive (host side) and negative (blank side) zones and then scored
264 using a chemotaxis index (26). The assay format was adapted from Grewal et al. (1994)
265 (27).

266
$$\text{Chemotaxis Index} = \frac{\# \text{IJs positive zone} - \# \text{IJs negative zone}}{\# \text{IJs in both zones}}$$

267



268

269 **Figure 1.** (A) image of the final host-finding assay; (B) host-finding assay schematic.

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271 **Immunocytochemistry**

272 Freshly emerged *S. carpocapsae* IJs were fixed in 4 % paraformaldehyde overnight at 4 °C,
273 followed by a brief wash in antibody diluent (AbD; 0.1 % bovine serum albumin, 0.1 %
274 sodium azide, 0.1 % Triton-X-100 and PBS pH 7.4). The fixed specimens were roughly
275 chopped on a glass microscope slide with a flat edged razor, and incubated in primary
276 polyclonal antiserum raised against GLGPRPLRFamide, N-terminally coupled to KLH, and
277 affinity purified (1:800 dilution in AbD) for 72 h at 4 °C. Subsequently, chopped IJs were
278 washed in AbD for 24 h at 4 °C, and then incubated in secondary antibody conjugated to
279 fluorescein isothiocyanate (1:100 dilution in AbD) for 72 h at 4 °C. A further AbD wash for
280 24 h at 4 °C was followed by incubation in Phalloidin–Tetramethylrhodamine B
281 isothiocyanate (1:100 dilution in AbD) for 24 h at 4 °C. Finally, chopped IJs were washed in
282 AbD for 24 h at 4 °C. Specimens were mounted onto a glass slide with Vectasheild
283 mounting medium and viewed with a Leica TCS SP5 confocal scanning laser microscope.
284 Controls included the omission of primary antiserum, and pre-adsorption of the primary
285 antiserum with ≥250 ng of GLGPRPLRFamide. Pre-adsorption in GLGPRPLRFamide did not
286 alter staining patterns.

287

288 **Whole mount *in situ* hybridisation**

289 PCR primers were designed to amplify a 200 bp region of *Sc-flp-21* (Gene ID:
290 L596_g19959.t1) from *S. carpocapsae* IJ cDNA. Template PCR products were generated as
291 follows : [95°C x 10 min, 40 x (95 °C x 30 sec, 60 °C x 30 sec, 72 °C x 30 sec) 72 °C x 10
292 min]. PCR products were assessed by gel electrophoresis, and cleaned using the
293 Chargeswitch PCR clean-up kit (Life Technologies). Amplicons were quantified by a
294 Nanodrop 1000 spectrophotometer. Sense and antisense probes were generated using
295 amplicons in an asymmetric PCR reaction. The components of each reaction were as
296 follows: 2.0µl of Reverse primer (or Forward primer for control probe); 2.5µl 10X PCR buffer

297 with MgCl₂ (Roche Diagnostics); 2μl DIG DNA labelling mix (Roche Diagnostics); 0.25μl 10x
298 Taq DNA polymerase (Roche Diagnostics); 20ng DNA template; distilled water to a volume
299 of 25μl. Probes were assessed by gel electrophoresis.

300

301 Freshly emerged *S. carposcapse* IJs were fixed in 2 % paraformaldehyde in M9 buffer
302 overnight at 4°C followed by 4h at room temperature. Nematodes were chopped roughly
303 using a sterile razor blade for 2 minutes and washed three times in DEPC M9.
304 Subsequently, the chopped nematodes were incubated in 0.4 mg/ml proteinase K (Roche
305 Diagnostics) for 20 minutes at room temperature. Following three washes in DEPC M9, the
306 nematodes were pelleted (7000g) and frozen for 15 minutes on dry ice. Subsequently the
307 nematode sections were incubated for 1 minute in -20°C methanol and then in -20°C
308 acetone for 1 minute. The nematodes were then rehydrated using DEPC M9 and incubated
309 at room temperature for 20 minutes, after which three wash steps in DEPC M9 were carried
310 out to remove any acetone.

311

312 The nematodes were pre-hybridised in 150 μl hybridisation buffer (prepared as detailed by
313 Boer et al., 1998) for 15 minutes. The hybridisation probes were heat denatured at 95°C for
314 10 minutes, after which they were diluted with 125 μl hybridisation buffer. The probe-
315 hybridisation mixture was then added to the nematode sections which were incubated at
316 50°C overnight. Post hybridisation washes were carried out as follows: three washes in 4x
317 Saline Sodium Citrate buffer (15 minutes, 50°C); three washes in 0.1x SSC/0.1x Sodium
318 dodecyl sulphate (20 minutes, 50°C) and; 30 minute incubation in 1% blocking reagent
319 (Roche Diagnostics) in maleic acid buffer (50°C). Subsequently the nematodes were
320 incubated at room temperature for 2 h in alkaline phosphatase conjugated anti-digoxigenin
321 antibody (diluted 1:1000 in 1% blocking reagent in maleic acid buffer). Detection was
322 completed with an overnight incubation in 5-Bromo-4-chloro-3-indolyl phosphate/Nitro blue
323 tetrazolium at 4°C. The staining was stopped with two washes in DEPC treated water. The
324 nematode sections were mounted on to glass slides for visualisation.

325

326 **Statistical analysis**

327 Data pertaining to both qRT-PCR and behavioural assays were assessed by Brown-
328 Forsythe and Bartlett's tests to examine homogeneity of variance between groups. One-way
329 or two-way ANOVA was followed by Fisher's Least Significant Difference (LSD) test. All
330 statistical tests were performed using GraphPad Prism 6.

331

332 **Results**

333 **The RNAi pathway of *S. carpocapsae***

334 As is the case for other parasitic nematode species, *S. carpocapsae* was found to encode a
335 less diverse RNAi pathway than that of *C. elegans*, in terms of gene for gene conservation
336 (21). However, the apparent reduction in AGO homologue diversity is offset by significant
337 expansions across several putative ago genes, to give a predicted overall increase in the *S.*
338 *carpocapsae* AGO complement (38 in total), relative to *C. elegans* (24, not including
339 pseudogenes) (28); WAGO-1 (nineteen), ALG-1 (three), ALG-3 (two), WAGO-5 (four),
340 WAGO-10 (two), WAGO-11 (three) are all expanded relative to *C. elegans*. Notably, no
341 identifiable homologue of RDE-1, the primary AGO for exogenously triggered RNAi events in
342 *C. elegans*, could be identified (Supplementary table S2).

343

344 The presence of PRG-1 and components of the piwi interacting (pi)RNA biosynthetic
345 machinery suggests that a functional piRNA (or 21U RNA) pathway may be present. Whilst
346 ERGO-1 is not conserved, two putative ALG-3 orthologues suggest that a functional endo-
347 siRNA (26G RNA) pathway may also exist, which is supported by broad conservation of
348 associated proteins. MicroRNA-associated AGOs, ALG-1 and ALG-2 are conserved, with a
349 small apparent expansion of ALG-1 to three related proteins in *S. carpocapsae*. Further
350 understanding of how RNAi pathway complements influence functionality will require small
351 RNA sequencing efforts, and functional genomics approaches.

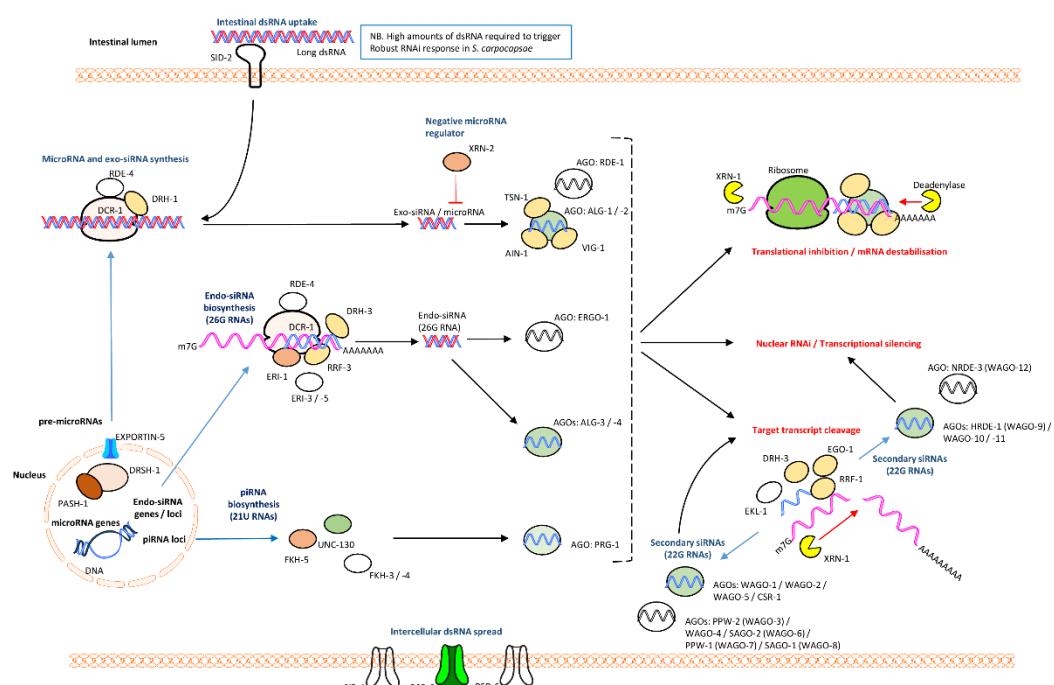
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353 The RNA-dependent RNA Polymerase (RdRp), RRF-3 is conserved, and known to function
354 antagonistically to exogenously primed RNAi, through competing activity for pathway
355 components required for both exogenous RNAi, and the endo-siRNA (26G RNA) pathway
356 within which RRF-3 operates (29-31). The RdRps, RRF-1 and EGO-1, which are involved in
357 the biosynthesis of secondary siRNAs (22G RNAs) are also conserved. Loss of the
358 argonaute ERGO-1 which functions upstream of secondary siRNA biogenesis in the endo-
359 siRNA (26G RNA) pathway in *C. elegans*, also leads to an exogenous ERI phenotype
360 (Enhanced RNAi), but is not conserved in *S. carpocapsae*, suggesting that ALG-3 / -4 may
361 be solely responsible for endo-siRNA functionality (32, 33).

362

363 The apparent absence of the intestinal dsRNA transporter, SID-2 is consistent with findings
364 from other parasitic nematodes (21, 34, 35). SID-1 also appears to be absent, however
365 CHUP-1, a putative cholesterol uptake protein which contains a SID-1 RNA channel is
366 present, and may assist in the intercellular spread of dsRNA. RSD-3, which also effects
367 intercellular spread of dsRNA is conserved (see Figure 1 for pathway overview).

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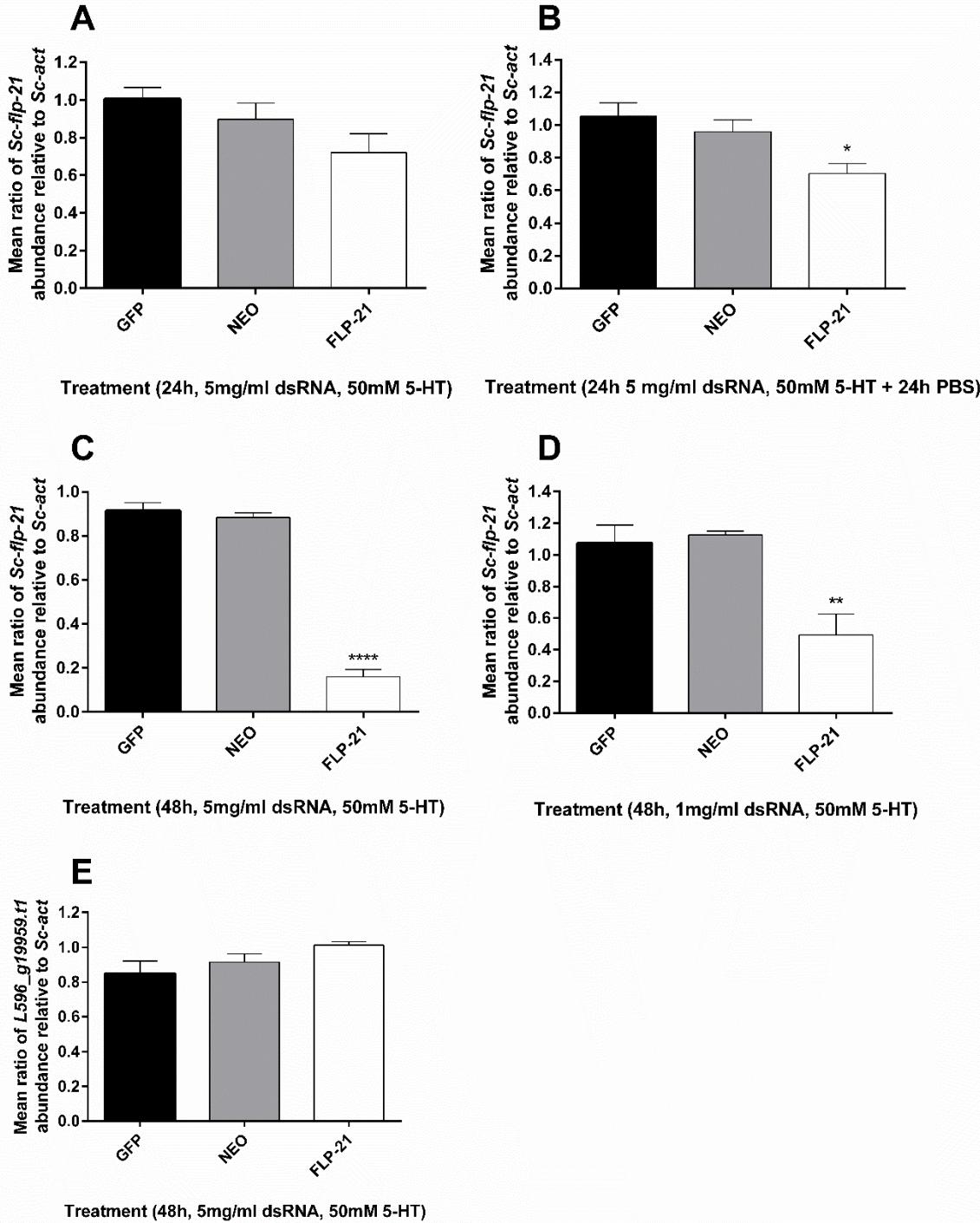
370 **Figure 1. Core RNAi pathway components of *S. carpocapsae* relative to *C. elegans*.**

371 Proteins with at least one putative homologue are represented in colour; those without any
372 identifiable homologues are colourless. See supplemental tables for information on number
373 of putative related homologues.

374

375 **Knockdown of *Sc-flp-21***

376 Various treatment regimens were employed in order to assess the responsiveness of *S.*
377 *carpocapsae* IJs to exogenous dsRNA. 24 h incubation in 5 mg/ml dsRNA, with 50 mM
378 serotonin was not sufficient to trigger statistically significant *Sc-flp-21* knockdown (Fig. 2A),
379 however a 24 h dsRNA / serotonin incubation followed by a 24 h recovery in PBS only, did
380 trigger a small decrease in *Sc-flp-21* relative to *Sc-act* when compared to *gfp* and *neo*
381 dsRNA controls (0.70 ± 0.11 , $P < 0.05$) (Fig. 2B). Extended incubation of *S. carpocapsae* IJs
382 in 5 mg/ml dsRNA and 50 mM serotonin for 48 h triggered robust knockdown of *Sc-flp-21*
383 (0.16 ± 0.07 , $P < 0.0001$) (Fig. 2C). 48 h incubation in 1 mg/ml dsRNA, with 50 mM serotonin
384 also triggered significant levels of *Sc-flp-21* knockdown (0.49 ± 0.27 , $P < 0.01$), however this
385 was not as effective as the 5 mg/ml dsRNA treatment (Fig. 2D). A BLAST analysis identified
386 predicted *S. carpocapsae* transcript *L596_g5821.t* as the non-target gene with most
387 similarity to the *Sc-flp-21* dsRNA (supplemental figure S1). The relative expression level of
388 *L596_g5821.t1* was unaffected by a 48 h incubation in 5 mg/ml *Sc-flp-21* dsRNA with 50 mM
389 serotonin, relative to *neo* and *gfp* dsRNA (1.013 ± 0.04 , $P > 0.05$) (Fig. 2E).



390

391 **Figure 2. qRT-PCR expression analysis of *Sc-flp-21* and off-target control gene (A) *Sc-***

392 *fip-21* transcript ratio relative to *Sc-act* following 24 h incubation in 5 mg/ml dsRNA, 50 mM

393 serotonin. (B) *Sc-flp-21* transcript ratio relative to *Sc-act* following 24 h incubation in 5 mg/ml

394 dsRNA, 50 mM serotonin, and 24 h in PBS; (C) *Sc-flp-21* transcript ratio relative to *Sc-act*

395 following 48 h incubation in 5 mg/ml dsRNA, 50 mM serotonin; (D) *Sc-flp-21* transcript ratio
396 relative to *Sc-act* following 48 h incubation in a reduced 1 mg/ml dsRNA, 50 mM serotonin;
397 (E) *L596_g5821.t1* transcript ratio relative to *Sc-act* following 48 h incubation in 5 mg/ml
398 dsRNA, 50 mM serotonin. *P<0.05; **P<0.01; ****P<0.0001.

399

400 **Host insect volatiles**

401 Comprehensive volatile signatures were characterised, and significant differences noted
402 between *G. mellonella* and *T. molitor* larvae. In total, we identified 10 compounds unique to
403 *G. mellonella*, four compounds unique to *T. molitor*, and 14 compounds shared between
404 both species. These profiles vary significantly from headspace GC-MS data presented by
405 Hallem et al. (36) for the same insect species (see Table 1).

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422 **Table 1. Headspace SPME GC-MS volatile profiles of *Galleria mellonella* and *Tenebrio***
423 ***molitor* larvae**

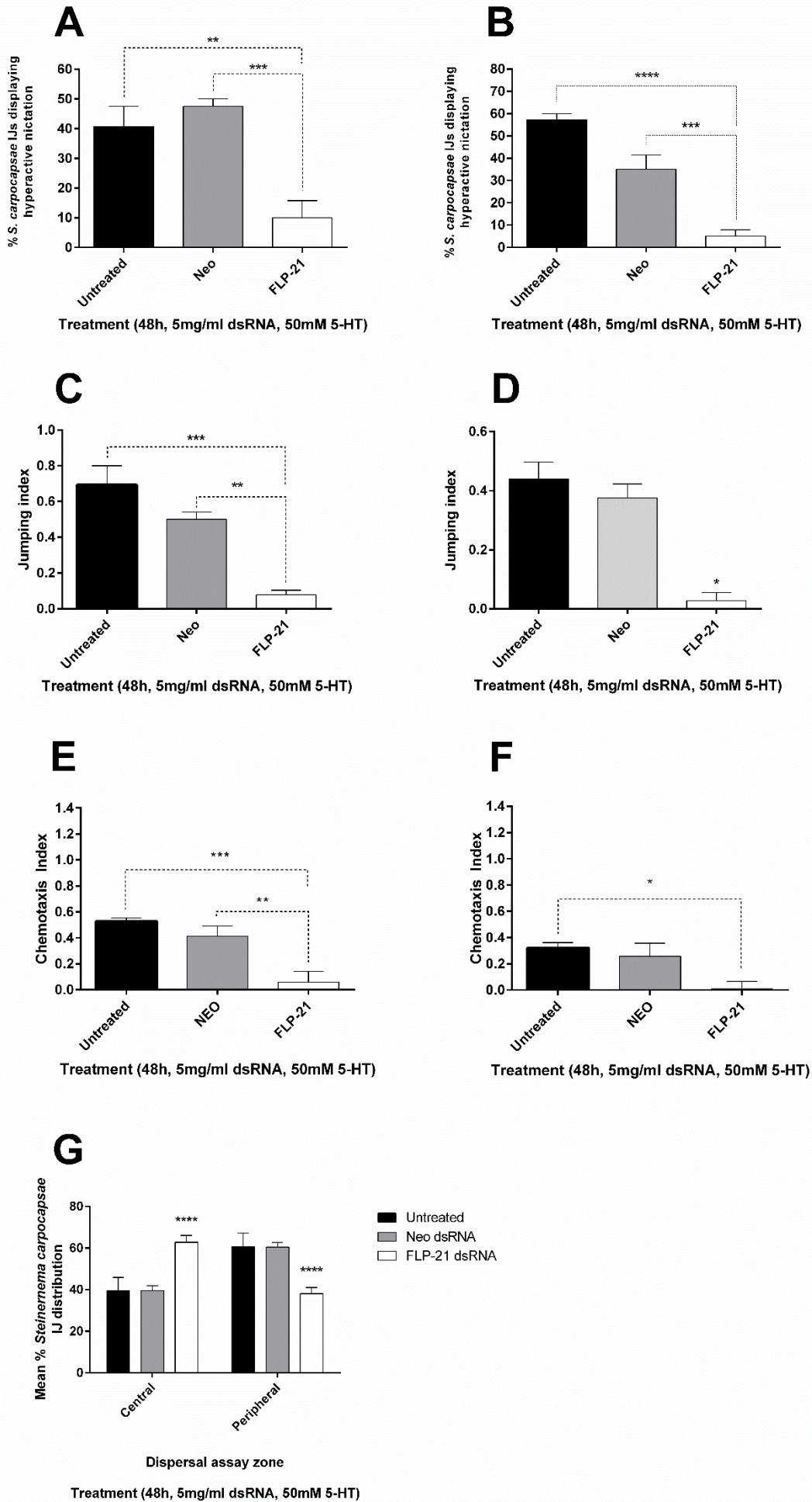
<i>Galleria mellonella</i>	<i>Tenebrio molitor</i>	Shared
α-pinene	decanal	nonanal
butanoic acid	1-tetradecanol-methyl ether	hexanoic acid
tetradecanal	1-hexadecanol	octanoic acid
tridecanol	cyclohexadecane	cyclododecane
nonanoic acid		decanoic acid
2-[phenyl methylene]-octanal		dodecanoic acid
tetracosanol		tetradecanoic acid
tridecane		pentadecanoic acid
1-heptacosanol		bis(2-ethylhexyl) ester-hexanedioic acid
cis-9-hexadecenoic acid		hexadecanoic acid
		heptadecanoic acid
		cis-10-heptadecenoic acid
		squalene
		octadecanoic acid

424

425 **Behavioural impact of *Sc-flp-21* knockdown**

426 *S. carpocapsae* IJs were challenged by exposure to volatiles from *G. mellonella* or *T. molitor*
427 following RNAi (48 h 5 mg/ml dsRNA, 50 mM serotonin) and control treatments. A decrease
428 in hyperactive nictation following *Sc-flp-21* knockdown was observed (10% ±5.774) relative
429 to untreated (40.75% ±6.75; P<0.01) and *neo* dsRNA treatment (47.5% ±2.5; P<0.001)
430 following *G. mellonella* volatile challenge (Fig. 3A). Likewise, a decrease in hyperactive
431 nictation was observed following *T. molitor* volatile challenge to *Sc-flp-21* RNAi IJs (5.0%
432 ±2.9), relative to untreated (57.25% ±2.8; P<0.0001) and *neo* dsRNA treatment (35.0% ±6.5;
433 P<0.001) (Fig. 3B). A decrease in the jumping index of IJs following *Sc.flp-21* dsRNA

434 treatment was observed when challenged by *G. mellonella* volatiles (0.08 ± 0.03) relative to
435 untreated (0.69 ± 0.11 ; $P < 0.001$) and *neo* dsRNA treated (0.50 ± 0.04 ; $P < 0.01$) (Fig. 3E).
436 Similarly, a decrease in jumping index as a response to *T. molitor* volatiles was observed
437 following *Sc-flp-21* RNAi (0.03 ± 0.03) relative to untreated (0.44 ± 0.06 ; $P < 0.001$) and *neo*
438 dsRNA treatment (0.38 ± 0.05 ; $P < 0.001$) (Fig 3F). An agar host-finding assay was used to
439 further assess the impact of *flp-21* knockdown. A decrease in *G. mellonella* finding ability
440 was observed (0.06 ± 0.08) relative to untreated (0.53 ± 0.03 ; $P < 0.001$) and *neo* dsRNA
441 treated (0.42 ± 0.08 ; $P < 0.01$). Likewise, a decrease in *T. molitor* finding ability was observed
442 (0.01 ± 0.06) relative to untreated (0.32 ± 0.04 ; $P < 0.05$) and *neo* dsRNA treated (0.26 ± 0.1 ;
443 $P > 0.05$). It was also found that *Sc-flp-21* RNAi resulted in significantly decreased lateral
444 dispersal, relative to both untreated and *neo* dsRNA treatment ($P < 0.0001$) (Fig. 3G). In all
445 instances, dsRNA treatment regimens which triggered lower levels of *Sc-flp-21* knockdown
446 relative to the 48h 5 mg/ml dsRNA, 50 mM serotonin approach, failed to trigger null
447 phenotypes (data not shown).



449 **Figure 3. *S. carpocapsae* IJ behavioural assays post-RNAi**

450 Behavioural impact of *Sc-flp-21* knockdown following IJ incubation in 5 mg/ml dsRNA, 50
451 mM serotonin: (A) Mean percentage of *S. carpocapsae* displaying hyperactive nictation upon
452 challenge by *G. mellonella* volatiles. (B) Mean percentage of *S. carpocapsae* displaying
453 hyperactive nictation upon challenge by *T. molitor* volatiles. (C) Mean percentage of *S.*
454 *carpocapsae* displaying standing upon challenge by *G. mellonella* volatiles. (D) Mean
455 percentage of *S. carpocapsae* displaying standing upon challenge by *T. molitor* volatiles. (E)
456 Mean jumping index of *S. carpocapsae* displaying upon challenge by *G. mellonella* volatiles.
457 (F) Mean jumping index of *S. carpocapsae* upon challenge by *T. molitor* volatiles. (G) Mean
458 percentage distribution of *S. carpocapsae* IJs across central and peripheral assay zones.

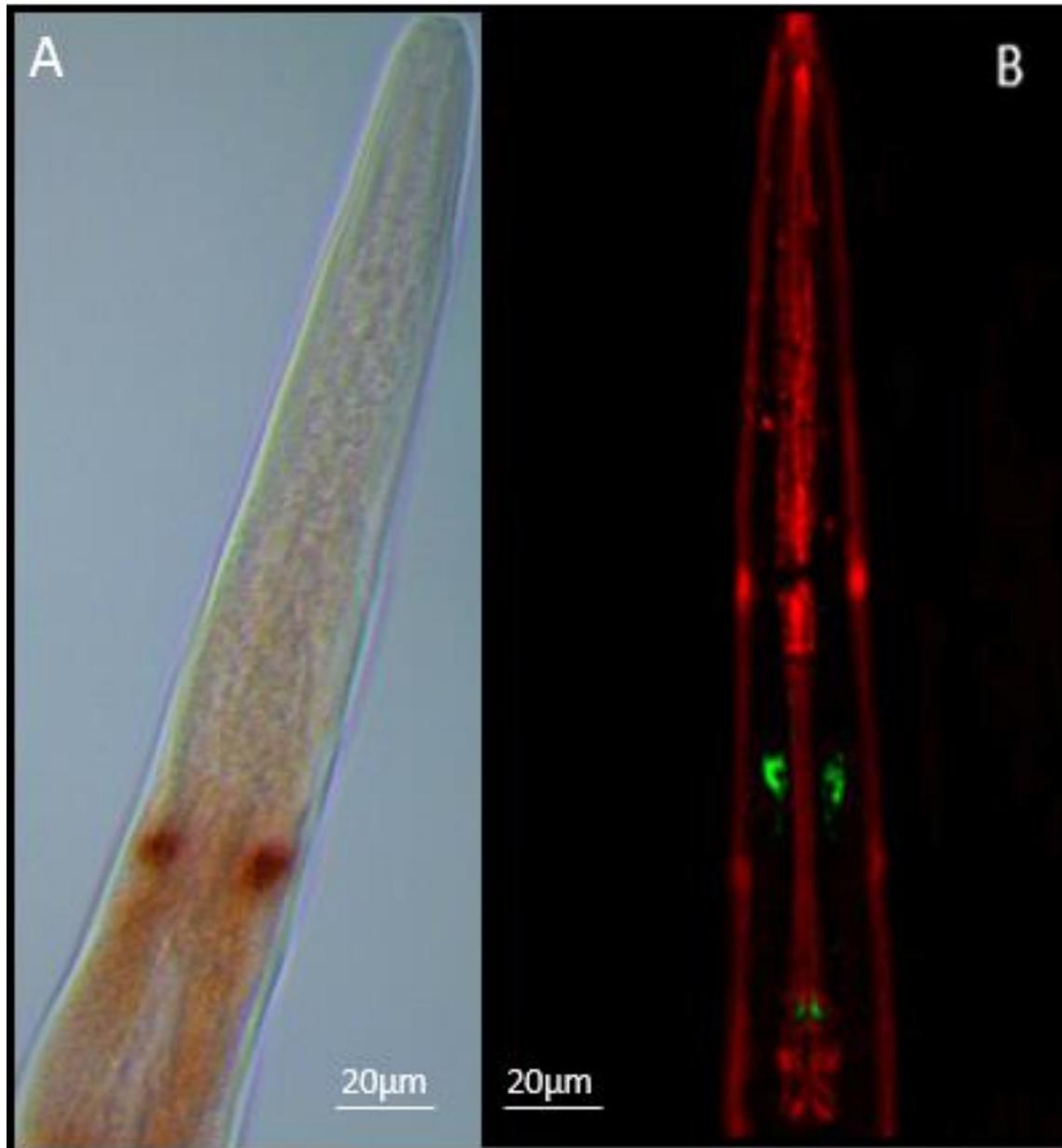
459 *P<0.05; **P<0.01; ****P<0.0001.

460

461 **Whole-mount *in situ* hybridisation and Immunocytochemical localisation of *flp-*
462 *21/FLP-21* in *S. carpocapsae* IJs**

463 *flp-21/FLP-21* was localised to paired neurons within the central nerve ring region of *S.*
464 *carpocapsae* IJs. Without additional neuroanatomical information on *S. carpocapsae* IJs it is
465 impossible to define these cells, however, based on the immunocytochemical localisation the
466 cells appear to project posteriorly (Fig. 4). These data suggest that FLP-21 must act as a
467 modulator of sensory function, downstream of the primary chemosensory neurons
468 (amphids).

469



470

471 **Figure 4. (A) Whole mount *In situ* hybridisation and (B) immunocytochemical**
472 **localisation of *flp-21* / FLP-21 (GLGPRPLRFamide) to paired neurons within the**
473 **central nerve ring of *S. carpocapsae* IJs.** Positive *flp-21* staining is observed as
474 red/brown pigmentation (A); FLP-21 immunostaining is visible as green, muscle is
475 counterstained red (B)

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479 Discussion

480 RNA interference is an extremely important tool for the study of gene function in parasitic
481 nematodes (37, 38). Three independent reports of a functional RNAi pathway in the
482 entomopathogenic nematode *Heterorhabditis bacteriophora* have been published. Ciche
483 and Sternberg (39) assessed the efficacy of RNAi through soaking egg / L1 stage *H.*
484 *bacteriophora* in 5-7.5 mg/ml dsRNA targeting a number of genes which had been selected
485 on the basis of phenotypic impact on the model *C. elegans*. Demonstrable phenotypes and
486 target transcript knockdown signified an active pathway. Moshayov, Koltai and Glazer
487 (2013)(40) employed the methodology of Ciche and Sternberg (39)to study the involvement
488 of genes in the regulation of IJ exsheathment (or ‘recovery’). Subsequently, Ratnappan et
489 al. (41) demonstrated that microinjection was also a suitable method for introducing dsRNA
490 into hermaphrodite gonads, effectively triggering the RNAi pathway in F1 progeny. To date,
491 no such assessment of a functional RNAi pathway has been published for *Steinernema* spp.
492

493 The RNAi pathway of *S. cariocapsae* has been characterised by BLAST and validated
494 through silencing *Sc-flp-21* in IJs. Our data indicate that neuronal cells are sensitive to RNAi
495 in *S. cariocapsae* IJs, and that knockdown is highly sequence specific. Like other parasitic
496 nematodes *S. cariocapsae* encodes an expanded set of WAGO-1 (R06C7.1) family AGOs
497 (19 in total) which function primarily with secondary siRNAs (22G RNAs) in *C. elegans*,
498 along with CSR-1 which is also conserved. Whilst RDE-1 is primarily responsible for
499 triggering the onset of an exogenous RNAi response, acting upstream of secondary siRNAs
500 (22G RNAs), it is not conserved in *S. cariocapsae* (21, 31). Our observation of RNAi
501 sensitivity in *S. cariocapsae* reveals that RDE-1 is not required to trigger an exogenous
502 RNAi response, however the functional significance of AGO homologue expansions relative
503 to *C. elegans* remains to be determined. The lack of SID-2 seems to correlate with our
504 observation that relatively high amounts of dsRNA are required to trigger the RNAi pathway
505 by oral delivery.

506

507 The nearest non-target gene sequence within the *S. carpocapsae* genome represents an
508 uncharacterised predicted gene (*L596_g5821.t1*). The *Sc-flp-21* dsRNA shared high levels
509 of sequence similarity over a 21 bp stretch of *L596_g5821.t1* (20 of 21 bp shared), however
510 qRT-PCR indicates that *L596_g5821.t1* had not been silenced, which could suggest: (i) the
511 level of sequence similarity was either insufficient for gene knockdown; (ii) dsRNA was not
512 diced in the correct register to produce this exact 21 bp sequence within a significant
513 population of siRNAs; or (iii) the *L596_g5821.t1* gene is not expressed in cells / tissue which
514 is sufficiently susceptible to dsRNA delivered under the conditions tested. In order to trigger
515 significant knockdown of *Sc-flp-21*, 48h continuous exposure to dsRNA was required in the
516 presence of 50 mM serotonin. Reducing dsRNA exposure time lead to a corresponding
517 reduction in *Sc-flp-21* knockdown, as did a reduction of dsRNA amount from 5mg/ml to
518 1mg/ml over a 48h time-course. Phenotypes which developed following 48h dsRNA
519 exposure were not observed across any of the experimental variations which resulted in
520 decreased gene knockdown (shorter exposure timeframes / lower dsRNA amounts). This
521 has potentially important implications for RNAi experimental design in other parasitic
522 nematodes, and notably in *C. elegans*, for which the validation of gene knockdown by qRT-
523 PCR is not common across the literature. Undoubtedly false negative determinations of
524 gene function will be a problem in this context. Our data demonstrate that statistically
525 significant gene knockdown levels are not necessarily sufficient to reveal gene function;
526 careful consideration should be given to the design of RNAi experiments as a result.

527

528 The neuronal RNAi sensitivity of *S. carpocapsae* IJs, and the ease of behavioural assays
529 makes these species ideal models for studying the neurobiology of sensory perception and
530 host-finding behaviours. Within the Steinernematid EPNs, a number of species also display
531 a highly specialised jumping behaviour which can be triggered in nictating IJs on exposure to
532 host Insect volatiles (18). Silencing *Sc-flp-21* triggers pleiotropic effects on host-finding,
533 lateral dispersal, hyperactive nictation and jumping phenotypes. The waxworm and

534 mealworm headspace SPME GC-MS profiles are expanded relative to those presented by
535 Hallem et al. (36), and likely reflects the increased sensitivity of analysis in this study. These
536 data could provide a valuable tool for comparative analysis of neurobiology and host-finding
537 behaviours across EPN species.

538

539 Collectively, these data provide the first mechanistic insight to a behaviour which may have
540 implications for biocontrol efficacy. Through isolating genes and signalling pathways which
541 coordinate these behaviours, efforts to identify molecular markers of desired behaviours and
542 traits could facilitate the identification of more suitable isolates and strains for biocontrol use,
543 and the enhancement of current strains through selective breeding / mutagenic approaches.
544 The selection or manipulation of behavioural tendencies could lead to strains which are
545 capable of operating within new ecological niches, expanding their utility.

546

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682 **Supplemental Data**

683 **Figure S1. Alignment of *Sc-flp-21* dsRNA against most similar non-target *S.***
684 ***carpocapsae* gene (McWilliam et al., 2013).**

685
686 CLUSTAL O(1.2.1) multiple sequence alignment
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688
689 exon_14_L596g5821 CAAATTCAAGAGCGCAGCAGGGATAAAGGCTTGTAGCTGGCCGAAAAGCCATCAGACGC
690 *Sc-flp-21*_dsRNA -----
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693 exon_14_L596g5821 TAATTGCGCCAGAACTCGGTCAGCGTAGTATTGGCGATCTTGCAAATGCATTGGACAAG
694 *Sc-flp-21*_dsRNA -----
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697 exon_14_L596g5821 TTTCTCCGTCAAGGTCAAGCCCTGAGAACTGCATCGCTGACATGCATCCTTCCCAGATGGC
698 *Sc-flp-21*_dsRNA -----
699
700
701 exon_14_L596g5821 CAAGTATTGATCGATGATGTGGCAAACATCTACATAAGAACTAGTGTGCCGAATCTCCGA
702 *Sc-flp-21*_dsRNA ----- TTCTG
703 * * .
704
705 exon_14_L596g5821 AGACCGGATTGGATTGTGGCGTCGAGTTGGCAAGGCCAGTTCCACGCGCCCGAACG--CC
706 *Sc-flp-21*_dsRNA AGCCGCT-----ATCTGAGCCAGTCAACGCGCCCGAACGAC
707 ***.*** : . *****.*****.*****. . .
708
709 exon_14_L596g5821 TTCAGCTCGCCGTGTCCATCCA---CTTCACG-----ACGACTCGGTGAAAATCT
710 *Sc-flp-21*_dsRNA CCCAGCGCTACATGTACTTCGATCAGCGCTGATGAAGCGAGGCTCGGTCCCTC----
711 * * . * . *. * : * * * : * * * * . * .
712
713 exon_14_L596g5821 GGCTCCAGTCGGATTGTCCAGCCGGTATTCTGCTTGGAAAGACGGTACTGACGAAATT
714 *Sc-flp-21*_dsRNA -----GACCTCTCGCTTGGTTAAC TGCTA----GAAAT
715 * . . * ** *****. : * * . . .
716
717 exon_14_L596g5821 CTTCCGCTGCCAGATGTACCTTCAGAATCGTACAAAGTTCTCATGGTCGCCCTCGC
718 *Sc-flp-21*_dsRNA CGTGATATTCAGAATTCTC-----CTCTTTGATCTTTGATTGTTGTC
719 * * . . * ****: * . * . * : * : * : * : * . * * * *
720
721 exon_14_L596g5821 TCTTCGACCGCGCTCATCAT
722 *Sc-flp-21*_dsRNA CCTGCGACT-----
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736 **Table S2. *Steinernema carpocapsae* argonaute proteins.**

<u>AGO Protein List</u>	<u>Homologues</u>	<u>Accession *</u>
ALG-1	x2	L596_g7718.t1
ALG-2	x1	L596_g16709.t1
ALG-3 (T22B3.2)	x2	L596_g3457.t1
ALG-4		
CSR-1	x1	L596_g20174.t1
C04F12.1	x1	L596_g11107.t1
C14B1.7a		
ERGO-1		
HPO-24		
HRDE-1 (WAGO-9)	x1	L596_g11197.t1
NRDE-3 (WAGO-12)		
PPW-1 (WAGO-7)		
PPW-2 (WAGO-3)		
PRG-1	x1	L596_g25491.t1
RDE-1		
SAGO-2 (WAGO-6)		
SAGO-1 (WAGO-8)		
T23B3.2	x1	L596_g21112.t1
WAGO-1 (R06C7.1)	x19	L596_g19943.t1
WAGO-10 (T22H9.3)	x2	L596_g19923.t1
WAGO-11 (Y49F6A.1)	x3	L596_g17524.t1
WAGO-2 (F55A12.1)	x1	L596_g16917.t1
WAGO-4 (F58G1.1)		
WAGO-5 (ZK1248.7)	x4	L596_g12936.t1

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738 * Accession numbers presented are the top returning hits for each RNAi pathway
739 protein.

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749 **Table S3. *Steinernema carpocapsae* non-argonaute RNA interference pathway**
750 **proteins.**

<u>Non AGO Protein List</u>	<u>Homologues</u>	<u>Accession *</u>
AIN-1	x1	L596_g5788.t1
DCR-1	x1	L596_g26648.t1
DRH-1	x1	L596_g26385.t1
DRH-3	x1	L596_g25860.t1
DRSH-1	x4	L596_g13580.t1
EGO-1	X3	L596_g919.t1
EKL-1		
ERI-1	x5	L596_g16241.t2
ERI-3		
ERI-5		
FKH-3		
FKH-4		
FKH-5	x1	L596_g10448.t1
PASH-1	x2	L596_g24740.t1
RDE-4		
RRF-1	x1	L596_g7841.t1
RRF-3	x1	L596_g11915.t1
RSD-3	x1	L596_g5786.t2
RSD-6		
SID-1		
SID-2		
TSN-1	x1	L596_g28061.t1
UNC-130	x1	L596_g11813.t1
VIG-1	x1	L596_g22586.t1
XPO-5		
XRN-1	x1	L596_g18210.t1
XRN-2	x1	L596_g10155.t1

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RNAi pathway proteins

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>AIN-1 - L596_g5788.t1

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MWGEETGAETMTLPWAGVSQQPQVWQNMNSRGNGNPSVANSVGSFAPNGGSVRPGSQW
DGGATPAGRSAWNPNPHAPRWTPSVNHGNASGWPNAQQHWSVANSNGTYAEQTKKNMALG
RSSGPNLNMSQRFDGSQGWGSKVDQGTPWDTGNSGGVSQQMHEGKEQWSNPTRWTQPPGT
WPTPIVAPMVADWQQGQPRHDHWANHPTGGMVPSSGAWAQQALGVASSSEQGRVPYDPNP
QTPGPWVAPQPAEMNNDMMWHDPNPKQKKIQKDVGTGIWGDPTSQIEIIRWKDLEAEGGE
FPGGSDWGSGSNSSTQPTGWGDVGPAQGNDGTDWRGAQGQALQGGWSDKVDQDRDLNGGK
SDLNQIQRGIQNAIANGALCPDGQSRLQQWKKQRGGIVGVSPEEKMGVASSSDSNVPSLI
AATKIMNIHGDWTPSSVADDSAKSEDQVSSSGTNNEKESSVKESASPTPPPQLDDGPQ
EFVPGKKWEWRDPNKVAEDPNATPGNCKPNPLMAAGNNMFAFSNSAVNTANPYGPEVPS
GNASTFWPNNSQGFNVPYGRDMYNSVRARLPSNGQFMPQRGMGGYSNSNHRMQTPPGK
GVFIVLNHQGANETQLNFSCTRAGQLLNVASLGGQTLLRYADSSSEGVLQKLADFPGN
ERIKTVSEEVEKLLKNRSPTMSGSAWAPNSDTPLWSNGGSPLATGEIMSSQNVFSNQED
LNRQQY

767

>DCR-1 - L596_g26648.t1

768

MSKFAGKPPQAPPRPQKLCGLKSTTRRGLHFDFGRAPAASKRFQISLANFKFWRRSGDS
LADRLOKRDENWILKLRLSPSDSAKAKNAQMVKATEINPNFFTFRDYQIELLEKALNYN
TIIPLGTGSGKTFIAVLLIKEYTQLLLKPFSNGGKRAVFIVDKVALVKQQADHIECHTEL
KVAQFHGYMNTDVCNTREAFEKVIEDSQVLVLTAQIFLMLLDHAIFSFDRVPVIVMDECH
HVLGGKHPYRLIVQRYSELSEETRPRMLGLTASLINKTAPSELEALLRQLETIMKCRIE
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KIHEIIKEFEQKVKTVRSYEELKKYIPHVERLLELLRYYHPNIQKTLQGGGVKSLSAMV
FVDQRYVAYAMNLLMKSLYKWNQIDFGHLRSDFVIGFNGTSLGEEAGFHKRQETVLEKF
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KLEFALNLRNFCEIERMLITRTVTIHDPHQVPARNVVQPYVVTSTGAKVTMSTAIA
LINKYCAKLPSDFVTRLVPQSCIEPVTVNGVTKFLATLSLPINSPFKEEIRLKTPMDTKK
LAQMAVALEACRQLHEKNELNDYLLPAGKDAIAATFLLDEDPDEYVPHMPHKAGSIRRQ
LYDKKMDLLVEASGAANPKRRKIANPLDNDYFFGFLSKRILPEVPSFPIFPRQGKVLVSI
KLCKNQITLDEETFERAMKFHEYLFDDVGLAKQGFVEFVPRHAPIATVIVPLKRREHAV
YDLDRVYLSNILEYRRIPYTPSEEERRTFQFREEDFTDAIVVPWYRNQDVFYDVAVINHS
LTPASGFPDGNYTNFREYYMKRYNLEIFNETQPLLDVDYTSTRMNLVMPRIPTRSQGKEK
KSDRTQHQVMVPELVNVHPIPASLWNSIVTLPTIIYRANALLADELRELICAALGPND
NSVHICWEPLDYVTSYSEDAQLPINKLSHLEKDLEAKERAKARAENPEPEIVDMEDDSND
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LIRTGENESLNLIYEYFMDNSNDSQEVERRMKKASLEIESSRPHLENFPVVEVEEGTPQKAI
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VSPCVLLQALTSHASDGINLERLETVGDSFLKFAVTDYLHFHEHKEQHEGKLSFARSKEV
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RSNQELVSYIERFQLSSVEKTIGYRFNNKAYLLQAFTHASYYKNRITSYQRLEFLGDAV
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FVRLCESQAKNTNFNSELYMVTEEEFDDGDEEDIEVPKALGDIIFESLAGAIYLDGRRLD
VVWEVFYNLHMHTIMECCEHPPKSPIRELLEREPKARFSKLERIRENGKIRVTVDIQQK

814

815 CRFTGIGRSYRIAKCTAAKRALRYLRDLDKEREAAKKASAHH
816
817 >DRH-1 - L596_g26385.t1
818 MNTHLKTSHPLSVINWDKFTPETPVAIRPEHFDLPRYQEELAHHALKGENTIIWAPTGSG
819 KTIVAVHIAQHLLKGNGRKVCVVNPNTLLEQQKRVcerHMDAKVNIKAESKAPFSGM
820 VAASHIVLLTPQMLVNALQNTTEGKENFSLSVFSMIVLDECHTAESHYPNVLMHHYHDV
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825 SPARVLIFVKEREYTYMLANIIDCCNELKALGVRPDFLISTNSGDGECLNPEEQR
826 KFRSGEINLLCSTSVAEEGLDVAECNLVIKYNYASSDIAHVQRRGRRARHQNSYAVLF
827 DKNLEQQENKNILSEELSNOIAALLRQMPQKMFEAEVQELVRKSYSDRVIERAA
828 KETASLALKDVGARTCTEFIGRSTDVRHSNHSLHILCDGSIWDRFTCEESVSQENFL
829 KTSelpIgkIYCNCNKEVWGRIVIFKGIAVPIIACKGILLQNARGERFPCA
830 KWAGIKGRYFCPEEVKSVDLARLSAAPHRPQFLTVLMGETESRSL
831
832 >DRH-3 - L596_g25860.t1
833 MTSNGTRFELDYVLTIVTTLDFILEPFFLFLALT
834 KSTPSMWFYRIFLIAISLCNAFSIVFFLLSAKFI
835 PIDDAVCLISHFALRSGRVLWQLSMFFMMIQFQIVLLMLIYSSYEISHPL
836 RPLNWRSKAVILAVFVFIFLPASLVLILEQQVIMGEIEEEKREKVPLSHVRLFR
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838 FDVVEILKKLFTINPGLARKFFF
839 RQIRLKHPKESGIIIP
840 IERCYGDDTEVLS
841 SELRLENLKNASKERYLKIFS
842 DDEFCA
843 GAGDTLSTQIRPQPF
844 IKNLA
845 AKYGNRY
846 EKMIKKVE
847 ALLKDKE
848 HAAACQILRSMP
849 KIA
850 DEDDSWWLH
851 LLDIC
852 DMDPHNRACLV
853 LL
854 L
855 D
856 E
857 D
858 E
859 D
860 E
861 D
862 E
863 D
864 E
865 D

866 GLRIDKARNDNRNSQVDRPSRKRGYENLREVMSMKGTEKAVLSPVHHNERLEFLGDSVIE
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868 HAMANTYEAMMAAVYLDCDLNECDRIFADTLFMDKEEKSKEKLAWTKLLDHPLKRDNPY
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870 VLQLVTTEYLYKHFVNHEGHLSSLLRTCLVCNRTQGVICDDLAMAKYLVIPPNSRKHTHV
871 MSIRWKERADLVESFIGALYVDRGLEYCKTFCKVCFPRLKYFIESQRWNDPKSQLQQNC
872 IALRDGKNEPEIPEYRVIAIEGPTNTRLYRVGVYFRAVRLADGVGHTVHLAQMNAAENAL
873 KQHADMWPSMSTKTEKKASHNNWERASYRREGNSAKYERSSNRQGGGNDYRNDLSGQDY
874 RKVPDGRESRRNSQNSDAPRSTFNAPYMQQNRRPYDNGQEKPFRSRNGQQYDDRSNQNDL
875 RGRNHHAPSYYQNEPSRFGPTRHRHDHEFRKPYDRPQHDFRHFTNDRRPHNESQNTSYGR
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883 HAVLLTLACSHVRYHWCLETFEKRIGYSFKNRTLLELALTHPSFRANYGTNSDHTRNALA
884 NCGLRIDKARNDNRNSQVDRPSRKRGYENLREVMSMKGTEKAVLSPVHHNERLEFLGDSV
885 IEFITTIHLFYMLTDLDEGALATYRSALVQNKHAVLAKKIGLDEFMLYSHGPDLCHESD
886 FRHAMANTYEAMMAAVYLDCDLNECDRIFADTLFMDKEEKSKEKLAWTKLLDHPLKRDN
887 PYGDRHLIPKIDSQQLTQFEDSIGIKFKHIRVLAKAFTRRCIGYNLTHGHNQRLEFLG
888 DTVLQLVTTEYLYKHFVNHEGHLSSLLRTCLVCNRTQGVICDDLAMAKYLVIPPNSRKHT
889 HVMSIRWKERADLVESFIGALYVDRGLEYCKTFCKVCFPRLKYFIESQRWNDPKSQLQQ
890 NCIALRDGKNEPEIPEYRVIAIEGPTNTRLYRVGVYFRAVRLADGVGHTVHLAQMNAAEN
891 ALKQHADMWPSMSTKTEKKASHNNWERASYRREGNSAKYERSSNRQGGGNDYRNDLSGQ
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901 ARSPKGFNVKSLDWFKYL FEEILSFPMSQPNQNQCSFYHCLPHFVHKEGKNVHLLPMIA
902 VLQHLQANFKPIFGVNDLFKNHRGENVVAKIRGQVVFNPDKTSALRLDHVEDPRDLLGQ
903 PKLVSFTKWKKSVHTRSRTKRKFMPNRRIKSDQTERPFFENAVPSKGYYKTGLYPDVQHA
904 LLLVPTVNYMRFHNLQILEVRIGYTFKDKTLL EALALTHGNFRGSYGPHRLIVKRQNETF
905 GFRTNLDTATKELKRPSSNGSKREPQTYERLEFLGDAVLGFI AATHLFYMFMSADEGTL
906 SLFKSKNVDNSRLCDLA KRSGLQQFILYECDRNLI IDEGSHPLL ANIFEALFGAIYLDGG
907 LNECDR VFADITFRNEQNGEENKLAWKNMLEHPLKRENPHGDRHLIPKCKSLLLTKFEK
908 SINAKFKHIRVLAKAFSRACIGLNNLTHGSNQRLEFFGDTILQFLTTEFLFKFPSHSEG
909 ALSLLRQGLVNNKALSTICDKLSMRTYIVV PEDMEKMEHVWILTEKSKADLVECMKRWKR
910 KAGRTRNPPSKKRSTSSAEALDAQIYLDTKFSATRDHQIIDLTMS P STSGTFNTLKLFKS
911 LFRGKQLGVGKERTIKKGEMEAAKNALESITEAVFKDMKRKLLEKKIDVPRGVCSYPS
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917 IDMARREQPQSEPPMTFHENCKGHVSESEADSSSGSESEEDDENADLSNVSDANKHS
918 LVAKREIARKQQHPAGLSQEMCFNEPGQMNDGPACRCSWASKQSGIRHSIFVGEERVEPC
919 NPMSSNLRNLHHYFMKVTNPVEQSRNASLIYHNDKGYVFEGFSVFFHRKLPQFFPQTPV
920 NKLSQEFEVVFIEEKAPEQFTVHDLESFHTYMFHDLEMYDLNRRAKDVFDGCPVYHCMP
921 RFVFKDYATEAVEVXXXXPKLQLLLTVCAFH
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923 >EGO-1 #1 - L596_g919.t1
924 MLAAENDRPPTSDDSQMELEGGTAVMDVKARDAPSKKAPRVPESDDSDLVRIITEAER
925 DRRMQLKLDKADFQKKVIHEMSADIAGCSASCKRVSEVPGNVNGVPKSAHFEVELTAPEW
926 DRAFFPMVHNFLQISKDYAETKKANALMQVSNPTLLREDFEPTNKLLPLQSFAFGCMRSP
927 FEFTNHHEFHSSSNAELLHDYFNHCREEPNHKEAMTIDFNHDLGDSFVFASEGNGYF
928 VYMLKLIYNKVRRIIVNFERLDSTTVHGVLFLFNNPIEVRRSQKIKGRKGDSYWRF
929 DTNGDRCLTWNNNEERQAI IADCLNLKLQFEKLEKNVLYNILSRLRRRCNVILEFSSVQE
930 VPFKGHVDRPMFGDHAIAKRLKEMDKYDVNYLIEALCSRGAVINDQFLESEKTRDDYVEM
931 ILEDYERNNSFITIAALERILNI IDEHLEVRIHLLYRTCFNEAAHEKDLKETEERRKAD
932 GFLKVRKIVITPTRVLFVVPENMMGNKFLREYDPDGLYSLRVAFRDDSGLKMNNNSVGSQ
933 LVEKTIRESFKGVMVAGKEFWIGSSNSQMRDHGCYFLLNQTRDMRKILMEKTGEFDEKD
934 PIKAQARFGQRFTQARAVPDFLSRDDYDFFDDIKGGEDENGERYTFSDGVGSISVHFARR
935 IAEALKLQNFPVPSVYQIRFRGIKGIVTLDPNLDYYRDHAKKYGIQERRKHHRFDLQIAFR
936 KSQDKFNARVDVEIDIVKFSTPTPMQLNRPMINIMDQVTAMQSEASHRRMCARVHQQLDQ
937 QLSDLGKCLVDEHKAREKLFDPRRVDVHLITTLEKGFLTEEPFFRSLIQCHVHTLNRL
938 RAKNQVQIPFNKGRRMMFGVIDESGGLQYQGQIFCQVTNNLQLKTPGVTAAKTIITGPVLMT
939 KNPQNVAQDMRMFNAVDIPELRHLDVVVFPRYGRPHPDQMAGSDLDGDEYAVIWDP
940 FFDRNEEPIEFPKPKPVPPADADSTDLVINHIVNYIQQDSIGVISYAFLVNSDLYGIDS
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943 LLDNYGVKDEAELFTGNISNARNRLSDKNDMSLFNTNYAIEQRVSTIFQTHREQFFDK
944 CGGYMELTVSDMTFIPTAPKINSRDLERRLCTEISPEMKRASAYYQVCYTLQPKRESRR
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958 ADCATIYFCLNYPVEIRRAKMKSQKGRNMSAFGTEFDRKGRDGERCLSWEGEDSENGRLK
959 QAIADSPVLALTLDYKDEGFYNVLRLRSRCKVPEFTHVKEKRSDYDPPDVLLHLRT
960 KSGKLNDFS VAYFVQAVFSRGALVKDALLRSEDVRNKFIAKICKQCDKNRIVAVCALERF
961 LNAIDEKRELDPIKLWDFLVNQVSGDIGTIQKQLDKNEKDGYTLVRKAVVTPSILLT
962 PELIMGNGLRDFVNNSSDDVIRVLFRDEDGTQMRKISVGEIIIQKVVGQVLEDGIRIAGR
963 HLCYLGSSNSQLDNGCYFFEKSQIPDIRKKMGTFKEMSVPKRMSRMGQFFTQAQRVQRP
964 LERKEYRESYDLIGGADLVNEPYTFSDGVGVMSVALGEEFSSRLKLNCGVPSCFQIRYRG
965 FKGVLSVNPMLEIRAWAEANLSDEDIKYRNNVFRSSQKKFDASKNAKLDsapFEVVK
966 YSAPCQISLNRPMDILDQVSEIQSYKAHERIWSRIDELEFEKQVAKAACSLTSEHYARER
967 LAELPKRIGTSDLKEEDGFMLTQEPFFRSЛИМSSVRLSMSKLRKNNVDIPSNIGLRVYG

968 IVDETGQLQYNQIFCQVSSSIFVKHPKKSALKRILKGPMVMTKNPAIVKGDIRRFEAVDI
969 PELRHLVDVVVFPRYGRSPMPDEMAGSDLDGDEYVIIWDPKFLFDKNEAMNYPRPLKTF
970 EKVREDEIEKKSCAFFIKYIIQDAVGMLAHAFLANSYYGIESEVCENVARKHAKALDFP
971 KTGDQPDALTAKMPTKSEIYEGKQIPQEKPDRYPDFMEKDHQRCYASIGLNGHIYRRARAL
972 DDILHRSVDRHLSDKIEVDPDLIVDGWEDYEDEAKTMNDYNSQIRSVLETYGIEDEGQL
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977 FHTDLPIFYPIDKLKEVQNIKGESVNLNHLLGGIGSVILLFLEFLSSYYFGHKMKSISFN
978 PLGLNSSLGSCYQKLFHAATKTYNEVIFSVDLQPPEEGKVHRSLREFEIEPFMIEL
979 PLQKESEGSEARYNLSDVEDQIKEMTGASHVRVRPLNDVFLSGVTRLMVSAKGTLLESSQK
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986 >ERI-1 #1 - L596_g16241.t2
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988 VLVDTHQKKIVSRFRFVVRPKVNPVLSAFCVELTGVQTADVDKAPRFSEAVLKFRWLFS
989 HVYPSGQHDFGGLMKSYAIVTDGPWDLGKFFQLECIRLECIRSERYNAKIPHFRAYINI
990 RRVFTLKYKKTHALSKVNLAGMLAVLGMEFEGREHCGLDDAMNLARIAIRMMEDGAEFRI
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994 >ERI-1 #2 - L596_g986.t1
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996 VVDYPFEIIEFPAVLVDTHQKKIVSRFRFVVRPKVNPVLSAFCVELTGVQTADVDKAPRF
997 SEAVLKFRWLFSHVYPSGQHDFGGLMKSYAIVTDGPWD
998
999 >ERI-1 #3 - L596_g8761.t1
1000 MSLEEL SALISEASKRKPRAKRGEAAPNGRYEDPKEFPAVLVDTHQKKIVSRFRFTFVR
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1002 DDDGLWELRNFLQXXXXSILTGLSVKKRNSAFIVQVRTTYPMHTASTDGLAKMSWGSDEG
1003 SISMAIAALRKSRAAFELEYPDLMAKTKPTPLPRQSPAQQVEPKSPAQSIAPTSSSED
1004 LHAHLAKIQVTQPSVYLPSRPAYPSVAPSVPTEAVVPQPEPPRGPPGFDRSAKPKE^TF
1005 DTRVMGGASQTDVQVVPREVPHVPSLPVAPARPRVDRSTKEAVARKEAEFQRNLFAVYE
1006 ACTQDFRNMT
1007
1008 >ERI-1 #4 - L596_g16232.t1
1009 MLAVLGMEFEGREHCGLDDAMNLARIAIRMMEDGAEFRINEKLVAEYADKYASFVPTIS
1010 TTGMSTAERDRRKWRLNLPYXXXXVYCGNAIINGRLIRITFKFSRIAWSQHLACEGVTKI
1011 EMLAAYVAFAEARRRLAQFVTYRES
1012
1013 >ERI-1 #5 - L596_g16263.t1
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1016 EGYQVPKHDFFPREVSXXXXKANLQKELEELQLNTGGTSQMRDRLKRRLRKDLPKY
1017 KDEFSRNKLQRHFDFLVIIDFECTCEDEVVSFRFTFVRPRVNPVLSAFCVELTGVNKAPR
1018 FSEAVRDEFSPGRESDEGQGRVSDQREARGGRVRGQIHRVCPRNFDHRHERRGAGSQMMW

1019 RLNL PYRIV NICK HRFM SEAY ADCD LYDED ANFY EKAAN RK
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1021
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1265 >CSR-1 - L596_g20174.t1
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1267 SAQLQKINTVRPEHRLKNIEDQMRRLHLWGDSQCPVLTGFGISIEQQLLSITAGVRTAPV
1268 IQFGSSTDKLQPGPKWEMALKKNRYRI PANVKSVALIYRCEDKDDVDVRLFTTKLRSTA
1269 KMRGMNVEVPLAVIRFSPNRQAGEGDEVLGRHVNEARSAGAEFIVYVSSKCIQDHILLK
1270 LLERRRLRTQHISLESVRAVVIENKITLTDNIIHKLNVKNGGFNYTPLIEHVGNSRELE
1271 LASGNVLVIGLDVAHPAPMNASQRRMMHSVDATIRSLEPSSIGIVANVIKNPHAFVGDYH
1272 FQTARREAVEPRILKERVKWIFDLLAQNRPHEQRPKHVVYLRDGVSEGQYTMTIRDELGA
1273 IREAVREIDPKYRPFALIIIVTKRHNKRFFDSSKGVGNPLPGTVVDHSVVRTDITEFFL

1274 QSHIPILGTVKIPQYDIPVNEGGFFMDELQAFANCLCHSHQIICTPVSLPEPVYAAHEVA
1275 KRGHNNFILEFRRSHPEMVPYVDGNVNIIDCEEVTAKLAYRGTPLEAIRFNA
1276
1277 >C04F12.1 - L596_g11107.t1
1278 MMGSKYPDKLPAHTKGNPVKPLVSNSFEVSLGDKIIHVYDVSIIQDCESRGRKKVIDWST
1279 SSGDSAKRIKLAWSKEIFKKALEVKKFASKEAALVFDFSKILFSSEKLKDHLCSAIILT
1280 PEDFDVLPSFEGNSKLCRGTYTVRIVPTKAGSHQFRANDLEKALAKNQEDHSLRQFLEVA
1281 TSFKPIQEGTHKFRRGILHDVRTSAPGRRDLQNGPFEIAYGISKGARIIGDMDPKAALV
1282 MDSKRFAVYSESSETFLEDIQKVLGDKDLKIHLPRITKMFQGVTLGHCFNKAVEVKFSSL
1283 SNVLAEKLTFENSDGQKSFIVDYLEERYENYQCRARRWPVVVDKFPGRSGDVCYYPLDIL
1284 YVKEGQLVPLPLQQEFGITQELLKEVSKPHLRSAEIGRAPKDELELNARNAHLREHGINVK
1285 QAPIKLEGYRAQPPKLGYANGQTAAVDANRANWEAGRYIYPAKVDSFRYFVRQGCMGRDQ
1286 ANLFLNKFLDMCRSKGLDMPKPQIEFIKGPLALKNLLSAEDKAVGKKSVTFVLVDSEK
1287 SKTHDALKFYEAKYQILTQQRSETTFKAGRQTMENIVAKTNEKCFGQNYAIHGDEFIST
1288 KDTLILAYDVWHPGASAQKRILDI PDDTPSVVGMSFNGGVHADGFIGFYAYQEPLQERV
1289 DVLKSYMQHILRIFKKTRGKLLPKNIVVIRDGVSEGQFDMVCQHELASIRAGCRQFANAEK
1290 VGWNPKFMVVTVTKRHDKFFFVQDGHRVLPNPPGTVVVDCTVTRPDMEIIFLQPHRPFQGS
1291 AKAAAYSLLVNELEIPKQKSGSDLWLTNFMLKLCYSHQIAPSSISIPEPVKQADEWAKRG
1292 AANLEFLKRENGDKSLDMHNFLKSSSEGSFYDWAALSDALGYHTKRLEGTRANA
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1294 >HRDE-1 (WAGO-9) - L596_g11197.t1
1295 MTSTSVNLNSFKIDISSETVHRVQQYELVFVLYKSFKPGFTATPSRTVPLGFKYKYNLDT
1296 FQNGDHWVGGYDIAYGPQNPVKIRMRKEMLFHFFEFFKQQFSHTLAIGDVVPMMIFDCDR
1297 TIYSNQQLKVGRGFSSHWSYIEHLPEKVQDHIDILCGNVSDFCGLSVFLNRVGEVDMTDL
1298 GSEKNPNKGVIQFLETLLWQPLYTQFTDHVIYGKTFDIAEKNRISVMQDGLFLATGYDI
1299 SVDLIPDYEKDMSKLMPVVRFTPSSVYQNYSRMDALLMSLSGTNGRDTLYQLEYDCKH
1300 PSIVEKLSQTVRGATVQFIYDSQIFEVDHLDPRTPHQITFLLQGRRRISVTDYFMAKYN
1301 IQITSELPVCARKTRYGMSFYPVEVLRVAPNTKAIHKYLPADVKDMIEKGTILLPSAVQQ
1302 RIKEAIGEMKLYSAGIRKHDMARINPFLFGVFGIALVDKDRPVRIAHHVSESPLIECYRR
1303 GATSTLMKTEQNHPGVWNKSMKFLPPFLKPADLGKPKVIRFVNFTVEEVHLINRFMDKT
1304 HKLRLKGIDVMKERTISGSERFGKIRDARDIFGRNKDYRTMLKAAEIDLSSGADLFYII
1305 GSTDPMNPTRDIFKLAETKPSDKRIVTQHIGCKTLCTVSTGLSKRSPGILESIVMKT
1306 MKLGGTNYTLREKDRSSGYRYGYPRSTHLIIAFDKVNPQHTDEKGEKLYHPKACAMTYMI
1307 PHTTGLITRGTYWFQTSNETNLMMISAFEELKFYHKDSRGYDPEKVVVYWDVSHGEKE
1308 VTQEMDAMMAIVAEQRGESVRGPFLTITVDQNHNTLLLPTEANVRDRRLSLQNVTAGTWI
1309 QESTIGESFTMVSYEESDDKMTRAVKYDVKVAETHMHSIQDLTHKLTYLQNSGWRSVSVP
1310 PLKGATKLAKRAMKSYDIMDQIRGRSGPIEKQLFEERVKEISDWIAVKHLTNYWA
1311
1312 >PRG-1 - L596_g25491.t1
1313 MDARTGQLKSFRAASRQNRPQTDESPLICFAYQNHPRFIVKRTKSISLLKTLILRRFDAL
1314 ASALMRQQKSIIYDFQMVIALTKF
1315
1316 >T23B3.2 - T23B3.2
1317 MRSRRIYSFNSSIEMSDEIPIRVVDNRNRDDLLKILLLVLIIVFPPAAVAVQANECSV
1318 HWWISLFLMLFFIIPSYIHAWWYVFIRKPKELTIA
1319
1320 >WAGO-1 (R06C7.1) #1 - L596_g19943.t1
1321 MSDFENPNVKRPVTRIVDDVEELFERLQLEPGKPVMA DKQLPGTTGRKVKLQTNIYGLSL
1322 QKIPVHRYDVNVIARLGGEREVLFTKRSKEDAVSTDRCRKCRTAFELAVNTFGEQFFGQER
1323 YALYYDCQSILYSMKPIPALEDKMSHELSLLPHHLTDFPAFTGLDAVVVEIKKVADTFNL
1324 NLGNLGFILNRELIEQDHSLQQFLELITSQHALFTPADHICYSGSTSFLNHKKYGFLED

1325 CPDLGEGKYLAVGSHKSVRFVEPGGRSGAHAAVVVDTKAAFHACENLIQKAMAIINLT
1326 POTHCRKNEVDKLRGQLKGFLVFHTKHGRRQRRLFPIASITEDTAADKQFEDPDGNDVTLQI
1327 YFQQKYGITLRFPHAPLVVQENKQTNYYPMEVCYVNDNQRVALNQQTPLQIQKMIRACA
1328 TPPAQVRVRQNKENMRAELNNSNRYLQAAEVRISSNNALILEGRVLQPPDVYYGNGVKAVV
1329 HPDKGSWRLQNKPHFLAVEIHRWAIYVVGTGNRDILDQPKFENFIRMYMAECRSRGIRI
1330 NDPCEHRILPADPEIIKDRIKAACEGECYFMYFITSDAVTDIHKIMKYAEREVGITQDM
1331 RMSSANDVVAKGKRQTLENVNKTNIKLGGINYDIRFNSPDLNVLRNDRLFLGFAMSHPA
1332 PQTQHERNKGVPAPSPSVIGFSANMKSSPVDFVGDCVFQEPRDEKIGVIRGVVNNVTR
1333 FRDSRGYLPKELIYRNGSSEGQYPLILKYEVPLIKKALEEVQCDAKVTLIVSQKMHNVR
1334 LMLSQINERDRAPEQNIKPGTVLDVGAVHPVYNEFYLNHSVSLQGSAKTPRTVLFDENN
1335 YNMDQLEYMTYHLSYGHQIVTLATSLPAPAYIASRYADRGRNLFNASNTNWNVLQDGQLD
1336 YNQITRDLISYGVSDLRDYRVNA
1337
1338 >WAGO-1 (R06C7.1) #2 - L596_g995.t1
1339 MDALKGHCESDETLKYKETALVSKSGTIRFYPQEAKKVLNWAVEPVMVEEDPYKEEDGAF
1340 YSLCHVNIEFLASGVHCIAKLLAPFSNFRRSSATKSSSRPKTANVENRSATEPMTNLR
1341 SKIAGPATKTASITVYLTMESVTTKMAHTMAPKLGAGTGGRPVPLVTNMYQAKMMRAQP
1342 VYRYDVAMEMRFGAKSVSLVKKTIDDMVAIDHKDKCRAAFRIAVRLHDKVLGSPVGLFYD
1343 LQSTLYAIDKIKDAKENTECKEIELCIPSDMLKNNDYFKDRNPDSVTITIKRVEADYQLS
1344 LGDLSFATDASKAHLNADLVQFLEIATTQYAYLKAGDVLTYSGLIYFSEKRRKLNNGNL
1345 LIIDGVQKSIVKIEGSQKGQPQLAVVLDPKKTAFHAKDVAVSDKIYEAGFMEDDGRVHPAK
1346 LETVKNQVKNLFVEVRYGKPKTRFMINGIDKESARVKTFLSSTGETTVESYYLKQYQIEL
1347 QYPLAPLLAANKVNGERTTIYFPMELCYVCDTQRVKNTQQTSKQISDMIRSCAMLPADR
1348 VKEIKDCAKRLQNLNGDAVSGSLRSAGLSVATQLTSVQGRALPPPEIVYKDNNKFSVDPNS
1349 GKWKATGAQKPKFLLGASINRWAMMCVADRPQPRDDALMKNFAEKMVRECQGRGMRVNNP
1350 VFYQAVQGRPDSLESMFRRAKQDNMEFLFFVQDGRLQAHKDIKFFERKYEIIITQDLNQQT
1351 CRSVVEQNKFLSLENIVNKTNVKLGLNYSLIVNAPNTQHLFAKGRILYLGFOVSHPAPLS
1352 DDQKAKGMKPKQPTVVGVAGNITNQPAFVGDFVFFQEPRDRMADAMETLVRDFALRYKD
1353 AVGVAPEVIIYRNGASDGQYQTILDVEVQEIRAALTAAGAGSAKLTYMVVKLHNVR
1354 MPAQITGIKAPEQNVKPGTVVDTNIVDPVFAEFYLNHSQTLQGSAKTPKYTVLYDQNNFP
1355 MSYLELMTYVLSYGHQIVGLPTSLPTPVYVAGRYAERGATLLSASRHDSDMCKFSELTEA
1356 LGYGSTKIGKNRLNA
1357
1358 >WAGO-1 (R06C7.1) #3 - L596_g15757.t1
1359 MDTRSQAQGGFDTSIKVVYEMAPKQYAPENKAPVDLVCNAYRLRMPQPSSDYPARVYVYD
1360 VTLTLTRADGSLLTLVKTMDDYTHYVSKQRCRSALEAFSQKFPFFRTNEQRIFYDLQS
1361 ILFTRVELPMRNLTEAMSIEASEFSRGFAEGGQGMQRLNIVVQKTQSGTSIGLTDIFSL
1362 SSDIAEVGQRHDLSQFIEICSSQNAYMNPDQRVTPEGGYSYERGNPGDLVDGSKRVWNGV
1363 RKSVRYLTGAGNPVPAVVL DARKSAFHKEGEMVSDKVYAMGLMNDDGSVFDYNIDNITRQ
1364 LKGLFVMVKHLNNQRTFPILKLDKTPATYRFTSDDGVEMSVADYMSKKYGTALLEYPKSP
1365 LVVVWMKQREVHYPMEMLYVCPNQRVTTNQQTSKLVSEMIKKCAIVPSERIKEIKHQATS
1366 LHLHDGALREVCIEVDPNMLHLQGKAVEAPKLKYGSSALSVERNTRGKWRSTSNTKFLHPV
1367 QIKKWAIVLPTGGKLTGQDSQVPTKFVDLMIKALIICKVQVGPAYTGMSSGCQLEEDF
1368 KECARDGYDFMFFIQDSKLQFHKDIKVMERRYEIVTQDLNLNTARNVQQRKHLSENII
1369 CKTNVKLGGVNYSIHIDRPEFADFFHDRRLYVGMQMSNSRVFELGDGSDEKAGKPTIIG
1370 ISANVDRELSSFVGDFMCGPANIEDLSSVTEIFKYYSEEFLKMRGHFPEEIVVYIGGIS
1371 DGDMKPLLRWHIPAIRHGLNTAKCTAKMTVIFTSKSHNVRFPKNVTGERAPEQNVKPGT
1372 VVDTGIVHPEFTEFFVTSHQTLQGTAKVPKYTVMIDDNNLSSLYLEMTYVLAFGHQIVA
1373 LPTSLPTPLYVAGRYGDRGGVLYNAFDGKDDLYAVNDQLTFATSKKLCGKRVNA
1374
1375 >WAGO-1 (R06C7.1) #4 - L596_g16574.t1

1376 MPTGEDPVLAEPVASTEAEDNASPRTPHAIHEAGDAIGLERRLEASTSARDGNFYVALGL
1377 PILQGVVGKKEALAVGPIELSTNAFGFVLPALPVWQYEIEIEGLLAGSERRVFFTKRS
1378 PDDAFKIRKSQECCRRLFQAIHKYAHFSEDNETFYDNQGLLFAIAPLDLSNEKMDCM
1379 LTAEELAALSPPTYASFSEVINTKNAANPMTVGHVMTYTSQVLENNSSRRLQQFLEVLT
1380 SQHMLANPNEFLTYGTRSAVLLDTSAHGLEAGHLTKDKEIKIGCEKSVKLVEGPMRGQP
1381 DGKAVALIDVKKTPFHPEGTVLDKARAILNREPDKPSDAPRLKKDLAELVVYTKHTSKEH
1382 RYVVENVIADTAVSMTFPWTEEGREVTLSEFFVQKYRQNISFPRTPLLVARFGRERKLIH
1383 LPMELCYVARNQRVTSRQQEVDSNISAKMIKACAIAPAERQLQIQETVNALQITSSNPYLR
1384 AARTKITAAPLIVTGHRLAEPKIAYANNEVLSPDARFGFWKPPNAHRRPKFFKPAVINSW
1385 AIVVLPSPQAFLQGDIISREILARFTDLFRSECRDRGMQIGQPVFTEFMKADVQQLRDLI
1386 KSLTRPDPSVCRPLRYVIFITNGGITFCHQPMKYFERETEITQDLKMQTVVNVVQQNK
1387 RLTLENIVNKANIKNNGGINVVIRNMPGQRPILKPGRLVIGLAMSYSVRRQAEIISTLPT
1388 AVGWAANITREEGELIGDFLLQESFKKDRVAVIQTIVDRVADAFKHGP GPKEVILYRSGE
1389 EGRFRAILEEDLAVL RATFDNMASKPKLTVIAVQKHHNLRLMPTKINRQDRPSLQNLVPG
1390 TVVDRYVTHPTFTEFYLN SHVAIQGTARTPKYTVLQDDANMSLEELEEMTFGLCFNHQIV
1391 SLPTSLPSPLYIAGRYAERGMTLYRQHQEHEEDQGT SASSPSGSSGEPHLDVERLGTHI
1392 SYGSSRKLIKHLRVNA
1393
1394 >WAGO-1 (R06C7.1) #5 - L596_g20961.t1
1395 MEREGTELRPSTIVRQTQAAASSAPAAQVSTSAGAPPAAFGIRGPATSAETSFSQLVN
1396 I IPTPPLEEKKQPGTTGREQFKLRTNVFGSLPKDAQVFRYSVDASGTLQRNDRRIEFAKR
1397 VGDDITYLNRREKCRHVVQVVAKNPAIFGDRRELFWYDSQSILFSRNQLDIGSEAQFVL
1398 DQSDIGQNTLFEGFAHLK MVIRPAQTNFAVSIGDLEAYIQAELFESDH ALQQFLEILTAQ
1399 YAFNTPTEAMSFGTRTAYLLQPEKYGFKPADCADVGDGKFLGVGCDKSVRFIEGPGGAGG
1400 QRAALVV DLKKTAFHKVQSLYEKAREI LNNRDPKSTDASRLRMQLKGIVVETKHSRRQE
1401 FAVDNVVADTPATKKFKDLTGHEVTLQQYFQQKYNITLQHPDSPIVLTDRTKKFAAFPME
1402 VCWVVDGQRVALAQQT PVQI QKMIROCAVPPADRQRQI LGLVQGLQLNSENKYHKAAGVG
1403 ITPTALQVQARLLQNP II VYGGKSTM PDEKATWRLARQKPVYLPKV KIDKWAMFVIRGG
1404 NRSDCVDQAILNQFSNMMVQECRARGMTV PDRPTGLSFIGASREEVQETLEKAKTEGNQF
1405 CFFITNN DVTHI HQFMKFQERKLSIVTQDLKMSSAFDVVKKGKRQTLENVVNKTNIKNGG
1406 INYSLRFDDPVFNMDKLLPKDRM VIGLSTTHPKPIPGKKEQDQAPQDKKKQMHEQRTGPP
1407 VPSVVGVAANVLTESIEIVGDCLFQQPNREEKIALLQPVIRSLMLQFMKHRGMPPVEIVV
1408 YRQGTSEGQFRNVM ELEYK MVKAA ALQOGLNPKITFIVVQKMHNVRLMPTDCKAGDRAPE
1409 QNVKPGTVVDTMVTHPKYNEFFLNSHVALQGSARTPRFTVLYDENRLPMDEIEALSHSLA
1410 FGHQIVNLTTSLPAPLYIANRYAERGHNIFI ASQEDYTKSKSSLQSPHSTTIEDNLDFSR
1411 MMNELSYCNSEL RDKRVNA
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1413 >WAGO-1 (R06C7.1) #6 - L596_g322.t1
1414 MSEELHAASKLKPTEGIASRKVKLT NHFTLSFKSSKPVYRDVAMVHYMMTKDGEKSRD
1415 MCKGERDDAAILERQRRCLVLMEA AKKVAHFTPSKSCCVYD NSKTLFSSEKLL ENQCAQI
1416 RIEGEHIPDGFKNHPKLQGYFFIEITPVSTNHKFTIDDLKSGVSDDL NTDHTLRQFYE
1417 ILTNAYAVTND SHMVFYGNLYDNDKG ESGRKKLKEARNLIFGVNKGARIIEGSSRLVAA
1418 LVLD SKKSTFFDDANNKG LAGNIR DILLGSHFNAQ PHEV VIGDHN RKT VVTYLKDLRVYCR
1419 YQEDRDFVIAGVTKEPIEDLYFEYGSTKTSVMDYHKQAYNTKILY PHWPAVIMQGPRSKN
1420 YFPIEVLGVSKGQRVPISKQTPGQMAETIHCAARPHIRFAEILKKLDGLNLASNPNEF
1421 LQSFGVKIDCNPIQVQAHRR LAPKMVYAGNKEVDYDDIKGNWFANNAYILPAKIPKWFVI
1422 TDRIDVSIVRKFAGILKDTMKMKRMTVGE PQFLEMPVAQLDGFLGKMAKELKPEDQSPFI
1423 LFADTNDD SHALLKLYEAKHQILTQH LRARTVIECLEPRKRLTVGNICNKLNCNYGLVY
1424 AVNPQDHAKTMYLSKG DVMVGYDVSHPEPQPAHERRLGI PPTPSVVGFSFNGGVHPGM
1425 FIGDYQFCAPRQERVDILEERI QWMLRVFTTNRKTLPSRIVIVRDGVSEGQMPMVLQHEL
1426 ESIRRGVKKLKAGYNPKFLVTTKRHAKRFFAETERGIDNPMPPLSVIDHTVVRPDVTEF

1427 FMQAHKAIKGTAKMPAYTLLLNEGMTLDQIQSFMMGLCFEHQIVNSPISIPEPVYQSDE
1428 WAKRGHSNILAFFRLMDCPDPQKPSQKMIQRYLKASENPTTGQPEVEGYDWVRISKMLCY
1429 RGRRLEKTRANA
1430
1431 >WAGO-1 (R06C7.1) #7 - L596_g9675.t1
1432 MLEIRIPPIVDDQKRRSETELNTVNVRTNVYEFLPTGTSEIYHYEVAVIGKLKSGRTVD
1433 LTARTTNDVLTLERRDSCRKVLGIVSERYPAVFDHNLVFYDQARLLFTSKNVEINTAAGI
1434 YSVILGCQDHDKDEMFAAFSVEFRLARVSVEVGNVQKYLNKNLRLVNHSLQYLNVL
1435 TSQHVANKTITFGNESVYLEQDDQCGVRNNVLGSGKLLKTGFAKASRLIEGLTEQPAAA
1436 LVVDLKKAFFHVQQTVDKARLILQADRKRCCGSQPRIEDTEDLSRELVGLVETKHGSR
1437 VRKYKIAGFDKSTPASRSFEKDGRNVLIADYFAQQYKVKVENLDTPLVIVRGYGRDFHLP
1438 MELCYVKDQRVGLKQQTPDQIKDMIKQCACVKPVVRIAIEIEKIVKGLRLIDERKDILGSKV
1439 GIKDKPLKVEGHLLPPPLIVYADKDTCNQRVPPSREPASNGTWSSLANTTPAAFFKPAK
1440 IEKWAVIAIHTEDNGDPHDERNKRILAQNTLETNILHQFATVTEECNRNGMTLPEAEHV
1441 KFLDDTSTTVRDFIHQAQLSFVLFCNNAIITHIHQSMKCYERKFETVTQDVRMATVNDIM
1442 TKRRFQTLENIVAKTNVKNGGLNYNVEMPSKNGVRELMPKGRLVIGLTVRVVVPKSPKE
1443 IEEDEKKAAEREKQHKKARDSKFARKESTTAKLKPIMTVGYAANFTDVPTEFIGDHLYQE
1444 YRETGDILGMQIIIFERVVLEFKRARGMFPTEIVIYRECTENSDFIGQLQLEQMLLKSAIK
1445 STASFRPGFEPKLTTLIAVQKRHHVRLMPIAMRREAKAPEQNLQPGTVVDRMITHPEFTEF
1446 YLNSHTTLQGTARIPTYVVLKDENNLSMHEVQLMTYGLSYAHQIVNSPTSLLPTPVYVAVT
1447 CAERGMNLAKHNFRAMNIKFNANDDYSKLEDQHVDISHLNEQLSGNCKLSSIRNNA
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1449 >WAGO-1 (R06C7.1) #8 - L596_g18735.t1
1450 METLTKAVANMMPVVNLASKREDAKPNAQERALPLQTNMFSLSMRDEVPVFMYSVDVFMK
1451 VRSKAISLVKHSRDDYIVIDRKNKCRAFRVVRANPAVFGNPGBKYYDLQAQLFTLEKL
1452 NMDNEDEGLELVIDGADARRSTDFAEIPLDGIVVQIKRAGPKFDLALGELQLKFVAQEPK
1453 SHELLQFLEVATSQYAFLETPSDFVTYPAGLSFIKQKDPKAGTELEGGKLLLDGAQKSVR
1454 IEGEKKTDGGGKLAVIDAKKTAFHKTQKVIEKVNDFGFLQSDGTVHRMRIPDLAKLLK
1455 HIYVESRYRKRTQRFLINDVNPDNARNKMFTRNGVMISVEQYYREVYNITLRYPLAPLIV
1456 SKPMKSKDSEEKMVCLFPMEVLFVCPDQRVKINQQTPRQISDMIKRCAMQPDVRVKETKN
1457 YAEKLQLNGPASQACLYAGVSIANEVVVKVSGRKLVAPEIQYDKKKIAVDSNTGTWRSSG
1458 REKPKFLVGSSLKKWAVYLLGVRQPLPDENLGRKFVMMRMLLEARARGMQWESPTAVKGVL
1459 GHVDNIEKLFKAAQKEGLEFLFFIGDQKVQVHTELKFERKYEVITQDLDLKTCRNVVEQ
1460 GKFLTMENVIAKSNMKLGGVNYSIQVNDPTIKQFFKPGRLILGFQVSHAAPLKPDIAAG
1461 VKPRVPTVVGVAGNVSKGDPACFGDFFYQTPREDRMLEAMDTLIADFAQRYKRATGKD
1462 AELIYRNGASEAQYTDLVRDEIPSIRDALQSAGFRGVKLTVMVVTKLHNVRMLPVAIKT
1463 GAKASEQNIASGTVVVDKGITHPKRAEFYLNHGVTLQGSAKTPKTVLTDDQGFTLQQLER
1464 MTYALSYGHQIVSLPTSLPSPAYIAGRYAERGALIYQGFNHTVQHDADLQTLNGTLGYGK
1465 SKLGDKRVNA
1466
1467 >WAGO-1 (R06C7.1) #9 - L596_g18947.t1
1468 MSNPShNGGRRPGANGNGNGSQPGGLEMRAATHVRQIIRSGASSGMSSEVRYYQELTQAG
1469 QQLHLEEKPPGTLCREELIVHTNVYGVGLPDVQVYRYDVCAGFLERNDRRVEFAKRAV
1470 DDVADTTRRNKCRAVVQLVCQNYANIIFGNHREYFWYDSQSILFSKNMLDGIPEREKKEFV
1471 LTQEMLAGNPMFRGFKNVRLNIQRVSNSFAINIGDLTQYISADLEENDHSLQQFILEILTS
1472 QYAFNTPSEAICFGSRAAYLMQPDKHGFKAQDCADVGDGKYLGVGCSKSVRFIEGPRGDQ
1473 RAGLVVDSLKKTAFHYEQSLLAKSRAILNREPRGNDAGRRLRQQLKGLVVERHAQKPVRFT
1474 IEQVSDETPRNKKFMLQPDNREVTLLQYFQEKENITLESQDSPIIVGDRLLTKFAVFPLEA
1475 CFVVDGQRVSMDQQTPTQIQKMIRACAVPPADQRQIILSLVQGLQLTSNVYHQAAGITI
1476 TEKPLLVRGRILPNPKIYYANNVVVSPDAQKATWRLDRQKPHYLIPIAKIEKWAMYSIRAG
1477 GRSDVLDQPTLLRFAQTMVTECRMGRGMQLGNPGEVSFIGCAQEEITATMEQAKKDGCFC

1478 FFITNNDVTHIHQHMKLLERQTGVITQDLKMS SAVDVIQKNKRQTL ENIINKTNMKNGGL
1479 NYTIRCEGLSNEQLLPSQRLLIGISTTHPKVAQTALEDRDRADKNEDPLTKKKPHHEKHH
1480 RSEHITPSVVGFAANFKKDPIEFIGDCLYQYPQRDEKIGVMQPLLRAVINEFSNNRGVPP
1481 NEIIIVYRNGINSISTMELEFLMVKAVARCQGITPKVTMIACQKMHNMRMLPAKINPRDRA
1482 PDQNLKPGAVVDSNVTHPKFNEFYLNHVCI QGSARTPRYTVLHDEGQFSMDELQALTYN
1483 LAFGHQIVNLTTSLPTPVYVAAAYADR GHNIYGVSQKD YTSRTSDLNSSTLEGNLD FNR
1484 IMM DLSYSNSELRSKRVNA
1485
1486 >WAGO-1 (R06C7.1) #10 - l596_g1747.t1
1487 MASVDVELREKTKIRQEADRMFKEDYgidvgstempakmmkpa aqntmslvtndlfpvkth
1488 QQMPIYRWDVDITIAGKNGKTFSLTKSDSDAVNRKLKTRSIFKRLVAAHPEKFGKLE
1489 ENYYDLESMLFTLKDLSTDQEADYVPLMAEDYVCYPGGVSFSVKEKTTPLAEGKYLGHGVQ
1490 HLTRDVANVDLSHKQFLEVVT SQYPLMAEDYVCYPGGVSFSVKEKTTPLAEGKYLGHGVQ
1491 KSVRYIENDGRSPCAVALDLKKTVFHSEINALEYLKMQNTYVKQLIESKQRAKDNDMTL
1492 KTACQRIKGLRAYTQHTKRQRVVTMDRVGPETANEARFQLQDGEEITVAAYFHRTYGAPL
1493 LF PNAPVAVERKPGSKDVNYHPLELLTIAENQRVTGELPQAVISDVIKQAAVPLDRQQQ
1494 IMRAHDLKISTNDYVDNVGTSIAPQMMQVKGRLLMTPKV VYGRNTQIEAREGK WRAERK
1495 TFLKPAGAARWT CMMLTNNRLGEQMMHNFLNKYVAVCRRNGMQMADPIEPFVVDWRRTDL
1496 QTEIDAFMKDCTQYQKLEFVLCIQDNNMHEHKYLKFLERQYGLITQDICTRTVERCIGNA
1497 SATIDNIVQKTNVKGGLNYGLEYKSPDGRHDVLSATTMFVGLGM SHSKPPKPDATGQEP
1498 SRPASVIGFAANVLAQSFAVGDYYFQKADRDEKIFAIVPIVTRLLEQWCEHHGGQMPKN
1499 VVFFRNGGSEGQFQ MILKYEVPLIKFAIEEFAKKS AVQQQFETKFCLLVANKRH NVRFFK
1500 SNITS GGRAAQ QNLQPGVVVD SGVTHPVFSEFYVNSHTLQGTGKTPRYT VLHND CGLT
1501 NQLEHFVFALSHGHQIVNLTTSLPTPAYI ANDYAERGM A VGFLRAS GAPVDEYETFNS
1502 KLTFAAMHPGSKFHHCRVNA
1503
1504 >WAGO-1 (R06C7.1) #11 - l596_g1696.t1
1505 MERFKKL PTTPLKARQVT LVTNHFR LNPTGRTVFR YDVAMS HTRMVK GTEKIRD LCKGD
1506 RDDAAILERNRRC LALMDA AFAA APFAST SAAVIYDN SKTLIAAEELDMRQCACIRLEGG
1507 TIPPGFINHPRFKEGYFTI QITPTSSNHLVIND LEAALAGDEA NPDRSLRQFLEIL TNQ
1508 ETLKKNSFMAFYGNL SREAADQRKL REARILKSGMSKGARIIGSSSDLVA ALVLD SKKA
1509 TFFDDTNKNGLAGNI RELLN RAPNDAPS RVHINDFDRPDIV KYIKDLRVY CLNKP DNTFQ
1510 ISGLTREPLRN VFFDMG GEQ LSVLEYHQ RDGARLAYSHWP AVIVQSPRGRNYFPIEVLGV
1511 CEGQRVPISK QTPGQM KV VVNDCAVLPN VRFAEIHQMLN ALN LASTTPN RYLQAF GVTID
1512 VRPMK ITAYRRQAPKIVYGGNIKVQYDDVKG SWFSSGPYVLPAKIPKWFV VYDGIDQRTV
1513 QQFVGVLQQAMKDKRMEVAQPKYMEMKVAGMDAFLSSIVKSLKPGERSPFVLF TDANEDS
1514 HAFLKLQEAHKQIVTQHLRTK TVRECIEPRKKLTVGNILNKLNCNFGLNHLVAPDHEKN
1515 YLQKADVMVLGYDVSHPEPQS PQDRRLGIPPS TPSVVGFSFNGGQNPEMFIGDYQFCPPR
1516 QERVDILESRIQWMLKVFN DHRKKLPERIVVVRDG VSEGQLDMVLQHEMASIRRG AAMIK
1517 EGYKPKFLLVVATKRHQ KRF FIDKS NG EVDNSMPLTV IDHTVVRPDVTEFFMQSHKAIKG
1518 TAKVPAYTVLQNELGMSLDEIQAFLMGLCFEHQIVSSPISIPEPVYQADQWASRGHSNVL
1519 AFFRVM DIEDPEDPSKKMINRYLKPVEDPLPGRPKFEYDWTRISKLLCYRGRRL EKTRAN
1520 A
1521
1522 >WAGO-1 (R06C7.1) #12 - l596_g18749.t1
1523 MPLITVEMSLFVAEGSVV IFFNAIVLLIIVTDSTL RESTELMFIGGLCFADMTDGIAYFY
1524 AGIHLRCNILSRTDDVMISRLECFQKPFMFFFFYGYQLPAMMIFIVALDRFVAVFAPMWQ
1525 RKVERSSKLMVMVAIFLWVTLTYVINVFLFHSYSTGYTTAQCFAH DVFLSQLWDFIIVQR
1526 SILILLCVLLYVPILIKTRRIFQSNDKSVQSNSFNV TIGLTMTCSVLLFIPDVIYFDL
1527 IMDFH LILYLLGLNKCVANFV IYTLRQKEIRKKIELICRRVFCNLKGPF DLELSKRRQRS
1528 NITRTLGI AKRCQSLSAV AWSVVLSSAVPQETWHVISRPPLGEARFDGRIDKGFIAPLLY

1529 FYVSKMSAGPSNLQPDVELRPATKIRHAAEIKFKEMGIEVGIPEMPPKIPVPPNGNVKLT
1530 SNLYAVRTSSQIPIYRYDLDITISQRNGKQLALTKKSDSDAVSIDRKLTKIIFFKMVQT
1531 YPELFSGVHCIYDLESTLFTLNDIMKDDPEAEPKTLVIEGLDGAKFQGTTSATVILKKC
1532 HDRFEVDLTNFSHLELNIESTDLSHQFLELVTSQIPMMSDSFVTFPGGVSFSMNASTTE
1533 LPEGKYLGHGVQKSFRYVENPQTRKPMAIAIDLKKTAFAVLTGLDYLSQLIVDDRPLHN
1534 GQKLPNSVFGSGALKKMKGLRCCLQYGNRYREVVIHEISNKTAQEHYFDREGQQITVEN
1535 YFYQMYNRLKCPTAPLAGEKKPGQKALCYPLELIRVLDNQRTGELPQKVIRDKHA
1536 AVVPALRIRQIQDSCADLGLFGNDYLQNVDTVIDSRPIGVEGRQLKNPKMVFGKNTSVES
1537 RNGQWPNRGAMRPPFFIPSTIRKWSVLMISNLQNGFASETMHTFVSSFINECRARGMTLP
1538 APSPDPWALNAREELKPQMEGFFSECPLGLGIEFVLVLQDDCFHEHKFLKFIERKYNVISQD
1539 VNMKTVQKCLQRAAATLENIVQKTNIKLGGLNYSIEMTNPAGTSNVFQPDPMYVGLAMSH
1540 SKPPKPDSTGREPPKPASVVGFAANVLPQNFAFGDYYFQAADRDEKIDSIVPIMHRILD
1541 MWCQHHEGQMPKNIILFFRNGASEGQQYKSILKFEVPLIKHALEKFRNNCGVEQMTPETKFS
1542 LVVATKRHNVRIFKANIQAGRNEQNLPPGIAVDRSIVHPMFAEFFVNNSHTTLQGTGKTP
1543 RYTIMHNGADFKIGQLEHIVFGLAHGHQIVNLCTSPTPSIAGDYADRGMVVLHEFLKT
1544 TRAEADQYDTFNEQLTYAALQPESRFHYCRVNA
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1546 >WAGO-1 (R06C7.1) #13 - l596_g18732.t1
1547 MLGKWRTRVVEFEAAEELDFRWEFDHMVAIFIQPHCRCLLGFGTRSTFQINTVYPKE
1548 LQSPAILFPDDPNGLCKRNLLVQVSLFLLLKSFQLHDFSSSQLSGRFLLLFRCESECE
1549 RKRPRFATFGLPNLRSSANVQLRYANSIAKTERAANRRSNPLQTNSSPGPARKTAPHRN
1550 PAANPKTCFAIGVRGQVADTVDRSFVPRGPLLTAPPALPSALPVFSPIRLFTPBPAA
1551 YFRQSTMMLHTKLAELSVADNAMKPTPATEFKETVEVVSSYFEISIGQNALAYREVDIL
1552 AISQRGQEKNLTRGPADDGAASLRRQLCHEVFNAALKNSNGFTKQGVRLPVYDCRATL
1553 FLPAPLKMEDDEVVILDKDADFAEMSKETLFTLDPTDVIRVRIAPTTQNAFEMDLRAELM
1554 KADFCEPDCEFARDRSFRTFLEMLTSVNAVRSGSHTQLGVGNFFDNDPSMIVDIDAKCL
1555 RPGLSKGVVVEKDDRPYPALVVDAKSSCFKAQNLAQSIMELGRQKGRPDDMWKTARFL
1556 FKDVRVISAPVDKGRVKSFPIRAITKMPATELNVKVKGNGSLADYYARVLKIKLQHPN
1557 FMCVEADVPGPKKEFFPVEVLFVSPNQRVPIEKTEANQSSIVLKANAIPDRRIKNIKDQ
1558 MSRMSLFANTPVMEAFCVCPDFIRLTAGVRVAPQISMGDRVKIDQKKANWAKEANGA
1559 NYKQESFSLDSWAFLYANTEPGLIRQFVQRYAAAQRRGFTVREPTILKFQDFERTFSE
1560 CIDNDIRFLMLIDPKYVKTHESLKLFERLCHVLTQHVSLERVFDVVQKNSRMTLDNILSK
1561 THMKLGGLNYVPIENVGSRFALDSGEVLVIGYDVAHPTAMSQERRLVRSLNLDVKSLE
1562 PSVVGITANCFSNPHEFIGDYHYQTARKESIDVSILERMVWIMRLLEKNRPDQCRPKHV
1563 VILRDGVSEGQYDMARNEEMAALRDGLKLVDPEYNPTFTLVIATKRHNKRFFGQDGRNYV
1564 NTDPGTVIDKTVVRKDVEFFLQSHYPLQGTVKIPQYNKLHDEANFSMDELQAFVNCLCH
1565 THQIVNLAVSIPEPIYQADELAKRGRNNYAELERRRTSEVPRMNEAGVIDCNALTILSY
1566 WDSPLEAVRFTA
1567
1568 >WAGO-1 (R06C7.1) #14 - l596_g20920.t1
1569 MEPSSQPPPTPSL PENMAPKIVGPRDIYERPVPIASNLFPLEMKADVP IFMYHVQIHMKI
1570 GAHEINLVKRHTDDYMHIDHKDKCRAFRFAVRSSPATFGDPKGLFYDLQGQLYSDHKLK
1571 DVLGHDLIVREEIGIPGEEAGRAPEFKNLGVEYLRLVEVEPTRENRPTMILGEMMATRAKM
1572 QESVSRELTOFLEVATSQYAFLTPSKMVTYPSGVSYFKPTTAEPVQVFPAAKELLDGVHK
1573 VVKLIDGKRGEMAVVDPKKAVFHKSNTVIDKTVEMGFLDRGSGTVLRETIPELAKKL
1574 KNLYVETTRYGKPKIRFAVHDVVLDTARTSRFNKGDMTSVEEHFKDEYNVILKPHAPLV
1575 VSTPLKKNPESLQLLYFPMELLFVCPNQRVLFNQQTAKEAFAIKA
1576 SASKLRINGASVQGCFKKAKIEVGNAPLTVEGRSLVPPHIEYRAQQVQDAVSGWRSSS
1577 RRGKPQYLVGGKIERWAMYVLSQAPSQAEEELGKNLLAKMEDEFQARGMQIAQAKFLATV
1578 KASPEYMKKIFDRAKAHQLEFLFFIQDTKICLHKEMKYYERKYEIIISQDLMETAKAVTE
1579 EGKYHALDSLIAKLNVKVGGTNYGLVGPSIPDLFKRGKLYIGFHASFSA
PADAEDPTVI

1580 GSSANVTQTSAAFGDMFFQEKNVDVMNTAMAKATLKVLRYKNVGHAPSEVVIYRSGS
1581 SEGQFGQILRDEVPALRNALQNAEADEAKLTLLMVNKQHSVRLMPSVIMPGSRAIEQNIK
1582 PGTVVDTKITHPRFAEFYLNSHQVLHGTAKTPKYTIIVDDSAHQIEYLERVTYALSYGHQ
1583 IVDNPTNLPSPLIAGEYADRGTLIKAKRKLGTVKDLEKDLPYMASQVLADKRVNA
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1585 >WAGO-1 (R06C7.1) #15 - L596_g16096.t1
1586 MSNNERVKTIQNGMETISISATMPVKKIANAPGAPIQVATNIYKVGLSQVPIFRYDVDI
1587 TLKLPGKDVKVVKKDRADHVIIQNKNKACKTFQKAVQKFVNFGNVELFYDCQSILFSL
1588 RKLNISDKGQEFTLSPNDLPEVYGHVDSVNIVKSvrekyQLTLNDLGFNSTQEVNGIKH
1589 DLAQFIEVATSQNALFNGKHSVYDGGSYLMSTGEAVRNEPSKQLITGVQKSVRFIEGQG
1590 KPEATLVLDAKTVFHKGQONLYEKAISVRNWPRNDQVDRREIKSLSQQFKGLSIKTEH
1591 QKTKEYELAGLSEFSATHKFDHNGKQMSVAEYFKQYNKNLHPNAPLAIAKNFFMGKR
1592 NTMMLPLEICTVLPNQKVSKQQETPLQTAAVIRYCAVLPSDLKEQIYTQVKELGFWGNKN
1593 LPITVDQQPIVVTGRQLPQPSIVFGGNQTVSVNPANGKWQATGVNVRNARLPFALPGNPM
1594 PWAVVLVGQGTQDTAKSFALAVKTECESRGLKMGDPSAVIQANYEDIEINARNNTFENLT
1595 KMTPRVKFCVLIENERSPAYIHALIKNEQNWRITQVTDSATVQQFNFALGPAQGYGKG
1596 QTLENICLKTNVKFGGLNHFIKPPQGHEKVFASDRMYVGLGISHASPISDAQRARNVKPS
1597 PSVIGISCNYLAHPQALAGTFVQEPRENKMVESLKKVFFDLATFKKNIRKVIPKEVVIY
1598 RVGASEGQYATILEQEVPQIRAGLKEAGCNAKLVLIVPSRTHNVRLFPQTIKKEDKASFQ
1599 NLKPGVVVDSVIVHPKFPEFFLNSHTLQGTANTPRYNVLVDDLQAPISDHEMATYMWSF
1600 GHEIVGSPTSLPSPAYIADKYAERGRVLAVEARRKDEKFLNEEGEVDFTEMTAKLSFAGT
1601 PLANFRVNA
1602
1603 >WAGO-1 (R06C7.1) #16 - L596_g21757.t1
1604 MSEISVDELSSYISLESMSIGSSAYHKAPVPDSSLHHPVELLSSYLEIGIQEGSKAYR
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1606 HVFFAQPLPEDFITIDLDDNADFTGITNYLYYMTGATESIQVKISKPQSEEHVLDLYESI
1607 FDTAPLDCDGNLEISSRDRSFRTFLELLTSGPASFTGSHVACGTSFYEATNGKDMKDGT
1608 MRAGLKKGVCVIERDGILYPALVVDSKTGAFFKEQNLKSMKEMNNGEVPRSAEPMWQK
1609 ARKLYKDRVVLVVSNVYKNSTQRRLTFPIQDFTREPASRQMMNMKGFRGTVEQYFRQKH
1610 LSLLHPHLPCAIHASNSKIPVPTFFPIELLFVCGDQKVPLEKSDRFHSETLLRENAVDPK
1611 LRKERTEVQLKKLGLWREKREKMSVDDKKDLSEDGTNLLAFGVIINEFIPIRAGVRVA
1612 PTIEVANSEKISIVQKTANWEKKLTNKRYFSSVEITNWAVICSQISAENPMIVRFLKQMV
1613 NVSKRRGIRMDSPMKYSLKSGSREFDDIFRHIAESGRHFVMYFSPLKEKQHDLVKWMEH
1614 HYSVVTQHVCLERIENVVTGRIQILDNIHKANMKGFRGTVEQYFRQKH
1615 VIAYDVCHPAPMTSRERVLRSMTSFDPISRSLDPSVVGIVANCVAHFAVGDYHYQAS
1616 RKEVDGRILDRVKWFELLAERRPNASRPKHIILRDGVSEGQYKMAEHEELSAIRRA
1617 VAMIDPNYHPTFTLVIATKRHNKRFYDKNEGIAVNTEPGTIIDKDVVRGDVTEFFLQSHF
1618 PLKGTVKMPQYAILCDEADFSQDEIQAFCVNCLCHSHQIVASAVSIEPEPIYAADELAKRGS
1619 NNFAEHVKIHGRKSLRKDPMPNPNLIDFEALTHELAYWKTNLEAIRFNA
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1621 >WAGO-1 (R06C7.1) #17 - L596_g18751.t1
1622 MSDQPSSSHQLDVQLRPATIIRQDAEKMFKELGIEVPEPIMPARI PVPPNGNVRLVSNFY
1623 PAHVNGQVPIHRYDVEMTIARRNGSQLALTKKSTSDAVSIDRKAKTKAIFSKMVATHPEL
1624 FTNMYSCIYDLESMLFTLKEIEVNLIIDGLGEMFQGTTSATVNLKKCHDRYELDLTNY
1625 GFLQADVGSQLSHKQFLELITSQIPMMSEEFVCFPGGISFGYHVDATPLSDAKNLYHGV
1626 QKSIRYVENPATKKPMAAVAVDLRKTTFHQSIINAFQYMCQAQVQVDRNGCLTNASSLTKVS
1627 KAMKGIRCKLTYGRRYREMVIHAVVNKSPrSTFFKRGEQDISVEQYFYEVYQITLRYPNG
1628 LMAAEKKPGQRELCYFPMELLEILDNQRVSGELPQAVVSAVIQAAVLPAQRQEIQQAC
1629 NDIGLFDEYLRNIQTTVEPRPIEIEGRLITNPKLIYGNVNLVDSRKGQWPNRGANKPKF
1630 FLPAVVRKWTFLMISEQRNGQATGTMNGFLKEFIRECQMRGMLPHPSSPYVLDTNRNVE

1631 DQLEEFMRDCSEGDYEFVFVLQDGIFKFHKLLKYLERKYQVITQDLKTQTGQRCLQRAAA
1632 TLENIVQKTNMKLGGLNYSQMTNPGRKSVDDESTMFVGLSMTHGKPPLKDSTGELPPR
1633 PASVVGFAANTLPQQFAFIGDYYFQAADRDEKIDSIVPIMTILLTKWSKHHDGQMPMVV
1634 IFRNGASEGQYKNVLRFEIPLVKYALEKFREAADVEQIHPETKLCMLVSNKHHSTRIFKT
1635 NVPVQGRAPEQNLEPGIAVDRAIVNPVFQEFYINSHTTLQGTGRVPRYAILNNDAYALG
1636 HLEHIVFGLAHGQIVNMTTSLPTPAYIASDYGDRGMVILTQFLREFEKLGYEHPVDAY
1637 QEFNQSLTYASLDPDCKFNLCRVNA
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1639 >WAGO-1 (R06C7.1) #18 - L596_g4755.t1
1640 MLSVEEQAIHPGRCGKRLQVNNSVNVRLPASRIYHYIDVVGHKRCGPKIVLSRSFFND
1641 SLGHERRTVLVNLNFNWLAYFNEERIFAQPRNFLFYDAKSNLYTRKKLNCKGEVVTISTA
1642 QLTEAQIEGLEEFLCVRVKFTeadPFEIVLNEPEEFRDLGGPLQNFLETLFMQHSLFKNY
1643 ESVVMNPLIQVAADYEARGIPEVEASTLVKDGSRIFPAIRTKLMNMEGPQALTMEGLHEA
1644 DHACLCFRWEPAVHSSVTLQDKARRALEKEGFESFFPFELDALNRELCGIRVFTELSGT
1645 KKYFIVDHVSERTAWTAVDGQTLKDFLKTEYEVTLKPDFLFLIVEKRGSDLIYHAMELCT
1646 VAPFQRPHKKLNVPFRKWDCHQMKNKASPSKHTDHAKRLRESVGLVNENVFLQGSGVTL
1647 ATEPMEVATARILESPMLRVKREGLFAVKSKEWRYPPHTFVHSAKIERWGVCILFQERM
1648 WCSDRYQAHIRLNNLMKVISDRAGGHGMRMAERFQEYPNVPIREGSSLSDQIEQVRLCFE
1649 RCKETFDpqFLFFVIQEGLHGLDCIEAFERKYQIAALDVNNNEALKMALAHCSSRQKSP
1650 MAQVLTSTNIEAEKALRTIMAKINTKMGGLNFEVVPNHNARLLLQDGYLFIGIHAFAWY
1651 EQQRATVVGYAANLRYPMAFSGDARVRKFDESPLPEFLAKIVKRCCIQFNKVRGVDPQHVI
1652 IYQSQPSKDLCLQLIVDRTAILLGEIGISTELTYVFVDEHHDIRLTNTHLNNNTSIEEQNL
1653 LPGTVIDTHLVRKGASEFFLNSHIGLVLSEVPKYTAHDFRSGLGDNLQSLTYTLCYAV
1654 QSLNAPVSVPAVLVAKNKARHGASCLKTGKVGARDVN
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1656 >WAGO-1 (R06C7.1) #19 - L596_g20173.t1
1657 MADEVIGRMRQLSICDDPAYALAPKLQRADKKSFVQHVDIVTSYVRINIVGPAKSYRYEV
1658 TIEALAEGRPNILTKGPADDGHAVMRRTCYFLLYAAALKSGAFGTGLHELPVYNGQ
1659 TLVYFAKPLDRDVIQVTLDQHDDFANVPEELLYMVSGNDTWRISLQKALVDSEMDLQTM
1660 FETGQADVENLSTHDRSFRTFLEMATQQAAHYAQSYTSIGNAFFEKDSRTRSLGDGKII
1661 RPGLTKGVRLIERDGVVYPALVVDARSAAFYKEQNLFLSVKECMDSGDPNMSMNDKWDRI
1662 DNLFRGMSIFLAT
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1664 >WAGO-10 (T22H9.3) #1 - L596_g19923.t1
1665 MSFRIPKKRKPEDEGAGGTIPPKQNYSSSSSYASASSSRQTSNGGKNASVYMNGFELQI
1666 GRSVEIHKEYIKLFGVFRKRNGDEDRKDLTQGSKEAKDDISIQLRRGCWEIFRAVVREN
1667 NSLFGDRNRHFVYDCGLIFYSIDAIFPETETKTGTFDVAILSRECQDYQAMKIEYSI
1668 KKVRDGTFTLGVAPEDKDDRSMQQFLEVITSQGVYAEGLDNLIFRNHRYDVKYDTPVLRN
1669 KPEYPFCVRHGSSKSVVAEIENSNKALQTILOLEKKTSPFFPRMNVLQFVDQSKSDIGE
1670 RIVRGLFVTTTHLKKQKVFRVADFSKMNCNDITFKMRDRQNEDEFREISVTEYYQEAHKF
1671 STRAGRHPVVERKKRFNGEKEENNYPMDCLEIMDGQRIMDKQSGDITAYLISEARVLP
1672 RQMGDEIKEELNHRVLNQEAEKYLEAFGVRISRDLRSDAKILQAPKIAYGDKEKYLTTD
1673 NGQKNAWKIDDALKFYRPKGKISDAGGENEQNRWIFAVLNEFQSERDHAAAKRFLGKLQDR
1674 AKLRGMLMLNPEVRCLDVRDPDTVNKKLSELQYAKANKVKFIMFIQYERKDMMSRDTM
1675 KQLETFKLTTQQITMSTVNKGAGDKGDRMVLDNILNKTNEKLGGINCIMKPSPQIAQWF
1676 SGNVMYMGLDISHPGLGGNALSSVTPTAVGMTFTKNRDEVQGRYWFQEAREHMLRSLKKQ
1677 IVFAIEEFNRCRSRRYPDKIVVYRGVSEGEYDKVKTDEVEQFMEAFREINFPGKRKPALI
1678 IVIVQRNSGYRLIPTQDNDFRGNDIAVQNVLPGTCAEVIGEGRKEFILVPHQAIQGTAK
1679 PSKYVLIYDEAKCITLSELETLTNTLCYSHGIVTSPVSCPSILYQAGDLAKRAINNYRIH
1680 SSRRDFGAMPPIEEVDKRNEYFDQMCMLQVTLDTRFWA
1681

1682 >WAGO-10 (T22H9.3) #2 - L596_g15911.t1
1683 MLPNRAPQGNELQRNRKVELQVNGYRMRINESKVMHEIKMEVAFNTLKGLRNVDLLARP
1684 ANDVIRQKRRRLIWSIFHATTRIKHPQQFLYNEYEVYDCGGALFALHQIGDGNRIEFVMK
1685 MADFPEEAKGQLHRAEHVILRLAFTTRILDLRQSNLYDGGEAGEQRCRFVQQFLDILTSQY
1686 VLGSQDHFLVFQNSRYSADPREDIEAHLSKVIKKGASKTINIVGDQKNQEALLFVEPRRSP
1687 FMADKKVLDIVEEVRELGRSSNAQLKKLEDLLKGIVVETIHQKDAVQFPVKGFSAEP
1688 AGVLSFTMDAGESTTVADYFKRRYHLHVDRDMLCVVCERRQQKFYFPCEVLVVLPGQRVH
1689 CSRQTPKLVEQLIKESQQLPSRMKEEVNHEREVYGFHELNQQLKAFNVTVDTELCTAVGK
1690 VLPPPVIQYEQRTVSADVDRSGQKITGRQWKVSGQRFVRPAPTPEKWVLCVFENALESES
1691 TRTFARAYVNAARSHGLILGEPIIERLQEVNQSTIYARGQAYKSNDVKFILFIFGGDRKN
1692 FERDIMKESETLFNYTTQAVNTKTAMKAISDRGAFMVLDNLVMKTNLKGGINHELANAQ
1693 DFPQGYLEKVLFKAGRFIGLDLQSPGMLGGADEFTLDPTVVGMTFTLGSPADMRTGYWY
1694 QPAKKKYISRLKDAIEDVLMVYQESVGSLPNDIVIYRAGVSEGDIIMVVSEEIPAIDYL
1695 TTLDNPDCPYRPHLTVMVAQKNSTMRLMPILVVHQTGRAQDENVEPGTSVSTNIVSARHT
1696 EFVLAQQALKGTARTRYIVVHEEEQFTVEQLENMTHQLCYLHGIVALPVSRPSPLYS
1697 ATDLVKRGRANWKVRMERKEGSHTPLGPVNDFFDPINEERLRFLPVTLPAKFWA
1698
1699 >WAGO-11 (Y49F6A.1) #1 - L596_g17524.t1
1700 MNKSSKIAAMPSFKKRPAENDDSPAPKRPAEKARRSQREEAPRRSHGGSKILMNGFRVE
1701 IEKAMTIHKYYIQLNGIFKKRKGEEIARDLTEGVHRDDVSMQRKRRGCWDVFRQIVKENE
1702 SLFGGNTHKFVYDCGRLFCMEEIFPKSETKTGTVDLATLPDRSQTFYRGALRIEWTIKK
1703 VEDGTFKLGVPEEARSSDRSAQQFLEILTSQGLYARGDDHLIFRNQRYDVQENAPVDKKS
1704 TYPFCVRQGVQKSUILCESAEKIATILQLEKKTSPFFPEMNLLDFVRQCSSDDKAMAVLK
1705 GLQVQTTHLKRQQKTRISGYSNTACKDIHFENRDGEKISVPEYFLKHAFRTAACQLPC
1706 VEEKRKPKQNNHYPMDCLKIVGGQRILSQKQEPEIVEHLISTARILPLKMADEIGEQLGKH
1707 IILNREAETFLRTFKVNVDRLNLETATLIKAPQIQYGKNQNGVNPAKTLTTERGQKNAWK
1708 MEDSLTFYRPGVVSDSGEAHRWMFVILNEPNQREHGDCRVFLEKFVARAGTRGIKIQFPH
1709 VEKKRIENSDPWPELQEIGQYAKSNGVKFVMFYERTGDIRKAMLLETTFALTQHVSL
1710 KTISKAAGDKGAFMVLDNLMMKTNEKLLGGLNTRVKAEPRAEWFERGTTMFMGFDVSHPG
1711 LGARNENGVTPTAVGMSFTKNSDLEVVGRLWYQEPREHLIPNMKDHIIVEALETFKKHSGK
1712 FPELVVVFRGGVSEGEYEKVQTKEVQEFDQQLKFSRKPILKIVVVQRNSGYRLMPAQ
1713 RNDFGYQKNEALVQNVPGTACADEIVDQKRTEFVLVPHQAIQGTAKPSKYVLLHDEAPK
1714 MSKEELSTIAHTLCFMHGIVTSPVSCPSILYQAGDLAKRASCNFKAFLNRKGGNVPIPPV
1715 EEEKEKRKEFFDALCEKLKITLDTRFWA
1716
1717 >WAGO-11 (Y49F6A.1) #2 - L596_g17422.t1
1718 MPFPRGKGYHPYRGKSYHRGFGRNNFQYRQTKREEHSSDSSPTDNQPSTSRSHDRCDDY
1719 KPKDEDDMKLYLSDRKPSPEPPEFQIRINAEPFNIDHAPKEVHTYELIFVMSQKLKKEKE
1720 PANHKLRTNAKLFSAEDIGLGWFDAEEEGQVYHGTDMSCGPTDVVRQRRKALLFQLFRH
1721 LINQSKEYFPGSKYVYAYDGQRILYSPEVLMDEGMFMAQLTDLPESVTQLLGPSDQENT
1722 EINAYIRKAEDVIDLHDFGTEARPIHIEGFLETLTWQHAFEGFEEHIVYGTRYFALNAG
1723 KKLKHCTGFKSIVGFEKRIELLPDYTCNSILLERSLRPVMRMTPKFDLFFDNSTAISLDD
1724 FAVLFFFREVEVDDLSATLQKKENLQKLNQVFKNAAVRTIHRDDGRQDTFMIDHLDERNPFE
1725 ITLKEEDEETVADYLGYGYKVDRNDRLPCVARKFKNEFAYYPLRTLVLPPNQKVASKF
1726 LPEDMRKSYQEACQNLPSDALNNIFTAMSQLNLSRASEDYNNEDEKVIHNNKYMENFKIT
1727 LESNQLIQMPAQRICEPRIAYRESTHLAQDGAWDYEKAAVFIDAVIKVRRIGLVNTCEDV
1728 GEDDLGEFISKLIGWLRNKTIDLKLTPEDIWWPDawanEFKAGKSKKEMLATAEKIIETS
1729 EVKLMFVICSGSADDEIHDIWKLAEVTNELVKVNKKDFVTTQCITPATLSNVLVKSTYQD
1730 EILTNIIIMKMNKLGGTNVLSKSPSNMESISPHIHSRMFVGIDVLOPEKTQLNGETPN
1731 NPTVVGISFTDATSKFYLRGTYWYQQSPTVSLCLLQKFDEALYWYDCHKMDSVPREVFV
1732 YWRDSRIQKNMEEVKMVLEDVICNRAKDVRDASKLFLIMVDTKPKTRLFTWETQFSGNA

1733 QTQNVQAGTFVRESYRKQFTMINHKSGAGLAHPVRFTMINDDVNEKDYVEAELEKTTNA
1734 LCFLQNTSTRSTSIPAPLYSAMDLAKRGMKNYETMDAVMREEERDEDRKKREARTPEAWH
1735 RYYKQLVKTHMSVMPIRDSKFWA
1736
1737 >WAGO-11 (Y49F6A.1) #3 - L596_g18655.t1
1738 MSPPRNNSNFNRGNGHKRPHGHNSQAKRVKWEHSSDSSPIYNQPSTSRSYDRQPKEEN
1739 DVKPLFSSRERSPRLRDLQIRINAFPNLDHAPKEVYTYELIFVMSQKLKREKEPENYKI
1740 RTNAKLLEAEDVGLGWFEAEEPQFYHGTDMSCGPMDDVRRQKRKALLFQLFRHLINQSK
1741 EYFPGSKYVYAYDGQRILYSPEVLKMDEGMFMAQLADLPESVTQFLGLDDQKNTEinAYI
1742 KKSDEVIDLHDFTGESKPIHGIEGFLETLTWQHAFEGFDKHIVYGRDFALNAGKKLKH
1743 TGFKSIVGFEKKIELLPDYTSSNMILERRIHPVMRMTPKFDLFFDNSTAISLEDFAVLFF
1744 RVEVENLPATLQKEENLQKLNQVFKNAVVRTNHRDDGRQDTFMIDHLDKRNPFEIIIVTEE
1745 DQETVADYLVDVSYKVDRNDRLPCVARRFRNELAYYPLRTLVLLPNQKVASKFLSEDMR
1746 KSFQEACQNLPSDLNNIFTAMSQLNLSRASEDYNNEEVTHVNNEYMENFKITLESNQL
1747 IQISANRVHEPQIAYQKSVKPAQDGAWAYEKGAFFVHPKKGVRKIGLVNTCEDVKEDVLG
1748 EFISKLIGWLRNKGIDIDLKLTKEIDFWWPDAFSDFGVMKSVKEMLAKEKILETSAVNHMI
1749 VICNGSAEDKTHDVWKLAEVTNGLAKKDRTNFVTTQCITPTTLGSILVKSTYQDEILTSV
1750 IMKMNKLGGTNVLTNSNRNYMSVPHITQDRMFVGIAVLQPEKTRLNGDATYNPTVVGL
1751 SYSEGSPNFYLRGTYWYQQSPSVDLSILKKTFAEALYRFDFKFLIPKEIFVFWRSGKFQR
1752 SMEEEKIALQEVIDKRVKDVNAKSPKLFIIISVNTKPTRFFTWEKFSGNAQTQNVQAGT
1753 FVQESFLRREFTMINHKSQAGLAHPVRFTMLNDEIGEQDYAEAEIERTTNALCFLQNNST
1754 RSTAVPAPLYSAMDLAKRGMKNYETMDAVIREEESEEERKKRETRTPEGWQKYYGNLMER
1755 HMPVPIKSSKFWA
1756
1757 >WAGO-2 (F55A12.1) - L596_g16917.t1
1758 MHAHRLQQLTDGINRNLNDEGIARRTPMSPTPSVGRHDKEITLTSNLYELHLAHGKVRVY
1759 HYTIKLSDYTGKTAEVHGDYGRVNLGSKLLAADTFMKRNGFRDHDFCDLAGMRIFTIK
1760 PIPRSEGNPRFYVSEATKDGNFAVCRDDGRPFELENIRDVFKEVRIPNLQDATLDAFINTA
1761 INKAACLAKSDLYFPIFETCYPKTGAPVARKDGRSLILGKTTSVERVEGRYGSSTPVVAL
1762 NVSAEFYMKNNLLDFCKQNIELNEKSVFDAASFQLLSDSMQGVTVRLICSKNPLLFTI
1763 KSLANKNVMSMLKYPLPNIKGTGLIKFLWETYSVRLTYPESFAAEVKPDFHVTDPRIFY
1764 VELLEIMPMQRALKGKKS CDGSAVDREKKIQEKVHQMERHVQAGLGLSMDDAPVEVEAG
1765 VLDLPKIVFADEKVVEVN PSSASWRFGSGECPERFARPAEVKELPWCVMLVSDVPPTKGM
1766 SKKAKFFADLLKKQAAERGLQMKEPMYHPTKQGKVEIERFFNTAVEFFVFLMAKSLDYH
1767 DFTKILERKYQVITQTVKMENAFDVVEDPNSTKSRKIVEHIVMKMNKLGGVNSTVKPSR
1768 HLFSHEEVRRLLIGFTLIEGPKITGRDAAA FNRFGGKIPAVVGSANMGSLEHEFLGDFT
1769 FQYLDHTNIVQDIKKIVATILERFRKTRRGDRPAEVVIYRKLEHFPRVIQNEIAPLKN
1770 LLEEKCHGFVSLIYIAMTKTHNIRFFPKGPPPEGDERKPNLVPGTVIDSGAVGGGLKQFF
1771 IASYSASTGTRPPRFTILENSKEAKIRDLELTFAHQTSRSLGVPA PLVVAKNY
1772 ARRGNVLAKNEAEKISDVDTSVGVETMIDRLPYADAPVLRDKRVTA
1773
1774 >WAGO-5 (ZK1248.7) #1 - L596_g12936.t1
1775 MEGEGETLRPSTVVRQARNAASSAGAPPAPGSRAATASVEKS FYSKLVNVPTPPPEEK
1776 KPHGTAGRQLKLRTNVYGLSLPKDVQVFYRSDASGTLQRNDLRIEAKRVANDITYLNR
1777 REKCRRIDQVVAK YSAIFGDRREL FWYDSQSILFSRNQLDISSEGQFVLDQSDIGQNPL
1778 FEGFAHLK MVIRPAQTNFAVSIGDLEAYIQAEVFESDH ALQQFLEILTAQYAFNTPLEAM
1779 SFGSRTAYLLNPEKYGFPADCADVGDGKFLVGCGDKSVRFIEGPGGAGSQRAALVVDLK
1780 KTAFHKDQSLYEKAREILNNRDPKSTDASRLRMQLKGIVVETKHGSRRQEFAVDNVVADT
1781 PATKKFKDLTGQEVTLQQYFQQKYNITLQHPD SPIVLT DRTKFAAFPMEVCSVVDGQRV
1782 TLAQQTPVQI QKMI RQCAVPPADQRQRI LGLVQGLQI NSENKYHKAASVGITPTALQVQA
1783 RLLQNPTIVYGRNSTMKPDEKATWRLARQKPVYLPKPAKVDK WAMFVICGGNRSDCVDQDI

1784 LNQFSNMMVQECCRARGMTVSDPTGFSFIGASREVVQETLEKAKTEGNQFCFFITNNNDVTN
1785 IHQFMKFQERKLSIVTQDMKMSSAFDVVRKGKRQTLENVNKTNMKNGGVNYSLRFDDPA
1786 FSMEKLLPKDRLVIGLATTHPKPIVGKKEQDEGPHDKKKQMHQQRTGPPVPSVVGVAANA
1787 LTESIEIVGDCLFQQPNREEKIALLQPVIIRSLMLQFMKHRGMPPAEIVVYRQGTSEGQFR
1788 DVMELEYKMKVAAALQQGLNPKITFIVVQKMHNVRMPMDSKAGDKAPEQNVKPGTVVDT
1789 MVTHPKYNEFFLNSHVALQGSARTPRYTVLYDENRLPMDEIEALSHSLAFGHQIVNLTTS
1790 LPAPLYIANRYAERGHNIFIASQEDYTKSKTSFQSPHSTTIEGNLDFGRMMNELSYCNSE
1791 LDKRVNA
1792
1793 >WAGO-5 (ZK1248.7) #2 - L596_g12936.t1
1794 MEGEGETLRPSTVVRQARNAASSAGAPPAPGSRAATASVEKSFYSKLVNVPTPPPPEEK
1795 KPHGTAGRQLKLRTNVYGLSLPKDVQVFYRVDASGTLQRNDLRIEFAKRVANDITYLNR
1796 REKCRRVIDQVVAKYSAIFGDRRELFWYDSQSILFSRNQLDISSEGQFVLDQSDIGQNPL
1797 FEGFAHLKMKVIRPAQTNAFAVSIGDLEAYIQAEVFESDHALQQFLEILTAQYAFNTPLEAM
1798 SFGSRAYLLNPEKYGFKPADCADVGDGKFLGVGCDKSVRFIEGPGGAGSQRAALVVDLK
1799 KTAFKHDQSLYEKAREILNNRDPKSTDASRLRMQLKGIVVETKHGSRRQEFAVDNVVADT
1800 PATKKFKDLTGQEVTLQQYFQQKYNITLQHPDSPIVLTDRTKFAAFPMEVCSVVDGQRV
1801 TLAQQTPVQIQKMIROCAVPPADRQRQILGLVQGLQLNSENKYHKAASVGITPTALQVQA
1802 RLLQNPTIVYGRNSTMKPDEKATWRLARQPKVYLKPAKVDKWAMFVICGGNRSDCVDQDI
1803 LNQFSNMMVQECCRARGMTVSDPTGFSFIGASREVVQETLEKAKTEGNQFCFFITNNNDVTN
1804 IHQFMKFQERKLSIVTQDMKMSSAFDVVRKGKRQTLENVNKTNMKNGGVNYSLRFDDPA
1805 FSMEKLLPKDRLVIGLATTHPKPIVGKKEQDEGPHDKKKQMHQQRTGPPVPSVVGVAANA
1806 LTESIEIVGDCLFQQPNREEKIALLQPVIIRSLMLQFMKHRGMPPAEIVVYRQGTSEGQFR
1807 DVMELEYKMKVAAALQQGLNPKITFIVVQKMHNVRMPMDSKAGDKAPEQNVKPGTVVDT
1808 MVTHPKYNEFFLNSHVALQGSARTPRYTVLYDENRLPMDEIEALSHSLAFGHQIVNLTTS
1809 LPAPLYIANRYAERGHNIFIASQEDYTKSKTSFQSPHSTTIEGNLDFGRMMNELSYCNSE
1810 LDKRVNA
1811
1812 >WAGO-5 (ZK1248.7) #3 - L596_g17875.t1
1813 MVCKGQATSEIELTTNAYGFLPFLSAKVFQYDVEIVGILSGTGRVNFTKCSKHDAFRAA
1814 RIEECRDLFEMVKQKYPEVFNAPDSNYFYDNGRRLFTKESLLPPLVSKQEFLNEFDVTY
1815 LDRDYSRFDKILFSAVEKAAEDPMVDKVEVLKHVKDSGKSIRLNQFLNVLTSQHALSNPVKF
1816 ATYRIGSAFFINADRYDHNHGVEDLTDDKEIRVGCEKSVKLIAGSSDDGSAIALVDIKRT
1817 AFHKSGGTLLKKAREVLGKWPQPCDANRLKPHFIDLAVYTQHGSKDRRYVIDDIAETPA
1818 TLKFAWVRGSKELTLVEYFHQAYSIEIKFPRTPLAVAMAKEGRTIYLPLELCFVSPHQRV
1819 TTAQQQATEEMIKRCISIPPLDRQKRIGRIVEAMKISDNPFLQIADTGCKLLSTIPLSVTG
1820 RVIAPPKIRYGHSEIQKSAFLKPAKINSWAIIVVLTAQDDPELARGDILSPSVLTKFARLF
1821 RKECKARGMQLPDPFLKEFMKADVDQLGELMRCLAQGDSTECRPLRFLIFVTNEKLTDL
1822 HHPMKYFERQCGIITQDMKMQTVVVDVVLHKKRQILENIVSKANIKNGLNYSVIIIPDVPG
1823 KRPILGSGRLIVGLFTSPTFKWQFEDSPSRPTALGYAANTTPNEGEFIGDCLIQKGRASA
1824 IQTILRRVLAEFKKQRRCDPADVIIYRSCEEGRKKTLEEDLAAVRSILKSSNPMPHTLV
1825 IAVQKRHGLRLMPTAIQRQGEQSENLKPGTVLDSCLTDPALTEFYLNASHATLQGTARTP
1826 KYTVVHNDVGLSLEEMETLTYALSFSHQIVPLPTSLPSPLYIAGTYAERGVSLYQQDRER
1827 GREGSLESCFTYGSSPGLKHLRITA
1828
1829 >WAGO-5 (ZK1248.7) #4 - L596_g24399.t1
1830 MDVLTEAMSKMLPMNIAPKIVGAQDPYERVVPLTANMFPLHMRAEVPIFMYNVQVFMKVG
1831 FREVNVLVKRNTDDFTIIDHKNKCRSAFRFAVRAAPQVFGHPSGLFYDIQAQLYSVRELKD
1832 VLGNDSLKKKEIIVPGEDARKAYDFQDIDLEYLRLVIEPVNGTNPSINLGEVLKQKNFS
1833 DEVPCELLQFLDVACSQHAFLTPTKFTTYPGGFAYFNPTSEEPARELPDAARLHNGVHKS
1834 VKVIEGSCTAGRCGELAVVLDPKKAAPHKPDTVVQKIQEMGFLQMASENVAPHRIPELA

1835 EALKNVFVETRHGKRRSRFAIHSVVAESARTNRFTKDDGQVTVEEHFKKEYDIALKYPHL
1836 PLVVSMPLRKKTPSNGRAPPRLLFFPMEVLFICPNQRVLRNQQSAKQNNEVIKSCAVAPE
1837 HRLKDVIASGQKMRINGPNVHGCLNSAQIQVESEPLKVEGRTLVPPNIDYKGQCQVQDSF
1838 TGKWRNFGRNKPHYLEGKGIRWGILYVLSKAPSSEEQLALKFDKMLVEFQSRGMQIDL
1839 PMFLATVKATPLYLRTIFEKARKERLEFLFFIQDKDLALHNEMKFYERAYEVITQDLRTD
1840 TARAVIEQGKNLSENIIAKLNVKVGGTNYSVNGPSVPDLFKGRUYIGLQASTNGPPAA
1841 GAHLPTVVGSAANVTAPSSFVGDIYFQKFGEMDLQGAMASTTEGYVKRYAAVHGRAPDE
1842 VFIYRSGTANTNIGQMLRDEVPAIRCALKNSGASRARLTLMVTKQHNVRLMPTNMTLGG
1843 RAIDQNIKPGTVVDQKITHPRFAEFYLNHQALHGSAKTPKVYVVVADDCSNPIQYLERVT
1844 YALSYGHQIVGMPTSLPSPVYIAGKYAERGAALLQTKRNLGGALDVDAEELAYANSKV
1845 LGFKRINA
1846
1847
1848