**Can a square-mesh panel inserted in front of the codend
improve size and species selectivity in Mediterranean trawl
fisheries?**

Journal:	<i>Canadian Journal of Fisheries and Aquatic Sciences</i>
Manuscript ID	cjfas-2017-0123.R2
Manuscript Type:	Article
Date Submitted by the Author:	28-Jun-2017
Complete List of Authors:	Brčić, Jure; University of Split, University Department of Marine Studies Herrmann, Bent; SINTEF Fisheries and Aquaculture, Fishing Gear Technology; University of Tromsø Sala, Antonello; National Research Council (CNR), Institute of Marine Sciences (ISMAR)
Is the invited manuscript for consideration in a Special Issue? :	N/A
Keyword:	Contact probability, bottom trawl, size selectivity, discards, square-mesh panel

SCHOLARONE™
Manuscripts

Canadian Journal of Fisheries and Aquatic Sciences
 Journal canadien des sciences halieutiques et aquatiques

**Can a square-mesh panel inserted in front of the codend
 improve size and species selectivity in Mediterranean trawl
 fisheries?**

Journal:	<i>Canadian Journal of Fisheries and Aquatic Sciences</i>
Manuscript ID	cjfas-2017-0123.R2
Manuscript Type:	Article
Date Submitted by the Author:	28-Jun-2017
Complete List of Authors:	Brčić, Jure; University of Split, University Department of Marine Studies Herrmann, Bent; SINTEF Fisheries and Aquaculture, Fishing Gear Technology; University of Tromsø Sala, Antonello; National Research Council (CNR), Institute of Marine Sciences (ISMAR)
Is the invited manuscript for consideration in a Special Issue? :	N/A
Keyword:	Contact probability, bottom trawl, size selectivity, discards, square-mesh panel

SCHOLARONE™
 Manuscripts

1 **Can a square-mesh panel inserted in front of the codend improve size and species**
2 **selectivity in Mediterranean trawl fisheries?**

3 Jure Brčić¹⁺, Bent Herrmann^{2,3+}, Antonello Sala^{4+*}

4 ⁺equal authorship

5 *: Corresponding author. Tel.: + +39 071 2078841; E-mail address: a.sala@ismar.cnr.it

6

7 Address of the institutions

8 ¹University of Split, University Department of Marine Studies, Ruđera Boškovića 37, P.P.
9 190, 21000 Split (Croatia)

10 ²SINTEF Fisheries and Aquaculture, Fishing Gear Technology, Willemoesvej 2, 9850
11 Hirtshals (Denmark)

12 ³University of Tromsø, Breivika, N-9037 Tromsø, Norway

13 ⁴Italian National Research Council, Institute of Marine Sciences (CNR-ISMAR). Largo Fiera
14 della Pesca, 60125 Ancona (Italy)

15

16 Keywords

17 Contact probability; discards; bottom trawl; size selectivity; square-mesh panel.

18 Abstract

19 An experiment was conducted to assess the selectivity in a typical Mediterranean bottom
20 trawl, equipped with a square-mesh panel inserted in front of the codend, for Atlantic horse
21 mackerel (*Trachurus trachurus*), European hake (*Merluccius merluccius*), red mullet (*Mullus*
22 *barbatus*), poor cod (*Trisopterus minutus*), broadtail shortfin squid (*Illex coindetti*), and deep-
23 water rose shrimp (*Parapaeneus longirostris*). The release efficiency of undersized
24 individuals through the panel was low. The differences in selectivity between the gear with
25 and without the panel were very small. The low release efficiency of the square-mesh panel
26 was caused by the lack of fish contact with the panel as they drifted towards the codend, since
27 the average contact probability was estimated not to exceed 9 % for any of the species
28 investigated. A low probability of contact with the selection device was thus found to be the
29 reason for the low efficiency of the square-mesh panel.

30 Introduction

31 According to Damalas et al. (2015) in the past 70 years, the practice of discarding has
32 increased in northern Mediterranean fisheries. There are many potential factors that could
33 have led to such an increase including inter alia increase in fishing power, changes in market
34 demand, changes in environmental conditions affecting fish community structure, progressive
35 introduction of regulatory measures, and changes in the selectivity of fishing gears (Damalas
36 et al. 2015). Indeed, 18.6 % of the total catch is regularly discarded in the region (Tsagarakis
37 et al. 2014). Discarding has been identified as one of the main shortcomings of the EU
38 Common Fisheries Policy (CFP), and is now being phased out by the new and reformed CFP
39 (Regulation (EU) No. 1380/2013). In the northern Mediterranean, large amounts of several
40 important species that are harvested with bottom trawls are often discarded (Tsagarakis et al.

2014). Improving the selectivity of fishing gears is considered as one of the methods that can reduce discarding. An effective way to increase the selectivity of a bottom trawl is to change either mesh size (Sala et al. 2006) or mesh geometry (Sala and Lucchetti 2010; Sala et al. 2008; 2015). However, these measures are not always well accepted by the fishing industry (Suuronen and Sardà 2007), as mesh modifications can sometimes result in the loss of species with relatively high economic value (Bahamon et al. 2006). Replacing a portion of the upper part of the extension piece with a square-mesh panel is a common method to increase the escapement of some species without excessively affecting profitability. Square-mesh panels are currently mandatory only in some EU fisheries (Suuronen and Sardà 2007). Studies of the effectiveness of square-mesh panels in improving size and species selectivity in Mediterranean bottom trawl fisheries are few. Özbilgin et al. (2005) first showed that a square-mesh panel can improve size selectivity for European hake (*Merluccius merluccius*), but not for poor cod (*Trisopterus minutus*). Similarly, Tokaç et al. (2009) reported that a square-mesh panel applied in the codend improved selectivity for Deep-water rose shrimp (*Parapenaeus longirostris*) but not for Norway lobster (*Nephrops norvegicus*). Metin et al. (2005) showed how placing a square-mesh panel in the forward part of a conventional codend significantly increased the escapement of undersized red mullet (*Mullus barbatus*), annular seabream (*Diplodus annularis*), and common pandora (*Pagellus erythrinus*). In a more recent study, Tokaç et al. (2010) compared the selectivity for European hake, blue whiting (*Micromesistius poutassou*), greater forkbeard (*Phycis blennoides*), blackbelly rosefish (*Helicolenus dactylopterus*), and four-spot megrim (*Lepidorhombus boscii*) of a typical commercial codend used in Turkish demersal trawl fisheries and of an experimental setup where a large square-mesh panel was applied on the upper portion of the codend. They found that the latter gear was associated with considerably higher mean L50 (50 % retention length) values for all species except four-spot megrim. This was confirmed by Kaykac (2010) for

66 blue whiting. Herrmann et al. (2015) demonstrated that the release efficiency of a square-
67 mesh panel in BACOMA codends, tested in the western Baltic Sea, increased considerably
68 when the panel was applied in the area where the catch accumulates, and concluded that
69 release depended more on its position along the codend than on its area.

70 In general, escapement through a square-mesh panel depends on the probability of fish
71 coming into contact with the panel. This depends on the size and position of the panel in the
72 trawl and on fish morphology in relation to the shape and size of the panel meshes (Herrmann
73 et al. 2009; 2015). Based on such considerations, this study evaluated whether the release
74 efficiency of a 51.6 mm square-mesh panel placed before a 51.9 mm diamond-mesh codend
75 in a typical bottom trawl improves size and species selectivity in a Mediterranean bottom
76 trawl fishery. The specific objective of this study was to investigate the size-selective
77 properties of the panel meshes and the probability of fish making contact with the panel as
78 they drift toward the codend.

79 **Material and methods**

80 *Experimental design*

81 The study was conducted in the Tyrrhenian Sea on board a commercial bottom trawler (206
82 kW, LOA 22.7 m and 67 GT). A typical Mediterranean two-panel bottom trawl was used
83 (Eigaard et al. 2011; Fiorentini et al. 1999; 2004; Notti et al. 2013). The net was equipped
84 with 230 m long sweeps (+6 m of chain), and Vee otterboards (1.65x1.00 m, 190 kg)
85 (SEAFISH et al. 1993). All the rigging components (Figure 1) of the gear coincide with
86 common commercial practice used in the Tyrrhenian bottom trawl fisheries (Prat et al. 2008;
87 Sala et al. 2009; Notti et al. 2013).

88 Figure 1.

During the sea trials, mesh sizes of the codend and the panel were measured with an electronic OMEGA mesh gauge (Council Regulation (EC) No. 517/2008) while the nettings were wet. Diamond-mesh size refers to the inside distance between two opposite joints in the same mesh fully extended in the N-direction, while square-mesh size indicates the largest diagonal. The codend was made of 51.9 ± 0.3 mm diamond polyethylene netting, 6 m long, with 246 meshes around the circumference. The square-mesh panel was made of 51.6 ± 0.5 mm polyamide netting and was mounted in the upper part of the last tapered section of the trawl belly, 8 m from the codline, inspired by the findings of Graham and Kynoch (2001) and Graham et al. (2003).

Real time gear performance data (door distance and horizontal and vertical net opening) were obtained with the SIMRAD PI50 catch monitoring system. The selectivity data were collected using the covered codend method (Wileman et al. 1996). A cover with a nominal mesh opening of 20 mm was supported by circular hoops to keep it clear off the codend and minimize the masking effect (Wileman et al. 1996). The cover, made from the same PA netting, was approximately 1.5 times larger and longer than the codend, as recommended by Stewart and Robertson (1985). A panel cover made of 20 mm diamond-mesh netting was used to collect individuals escaping through the panel meshes (Figure 2). The panel cover was based on the design described by Wileman et al. (1996) and supported by detachable floats (Figure 2). Details about the covers can be found in Brčić et al. (2015). At the end of each haul, the catch from each compartment (codend, codend cover, and panel cover) was sorted and the length of all individuals (or a representative subsample for large catches) of Atlantic horse mackerel, European hake, red mullet, poor cod, broadtail shortfin squid, and deep-water rose shrimp, were measured to the nearest 0.5 cm.

Figure 2.

114 *Selectivity model for the gear*

115 The selection device was a 51.6 mm square-mesh panel applied before the 51.9 mm diamond-
 116 mesh codend. In this experimental setup, fish entering the trawl first encountered the panel
 117 and could escape if they swam up through it and if their body size, shape, and orientation
 118 allowed them to pass through the meshes. If any one of these requirements were not met, the
 119 fish entered the size-selective codend, where a further selection process took place.

120 If the fate of one fish is assumed to be independent of the fate of the other fish, the number of
 121 fish of length l retained in the three compartments, codend (CD), panel cover (PC) and
 122 codend cover (CC) (Figure 2), can be modelled using a multinomial distribution with length-
 123 dependent probability of being retained in the codend $r_{comb}(l)$; escapement through the panel
 124 $e_{panel}(l)$; and escapement through the codend $e_{codend}(l)$. The combined retention can be
 125 modelled as:

$$126 \quad r_{comb}(l) = 1 - e_{panel}(l) - e_{codend}(l) \quad (1)$$

127 where l is fish length.

128 The first selection process takes place when a fish encounters the panel zone, where it can be
 129 size-selected if it makes contact with the panel. We assume that the probability of fish
 130 coming into contact with the panel can be modelled with the length-independent parameter
 131 C_{panel} . This parameter can take values from 0 to 1, depending on the fraction of individuals
 132 coming into contact with the panel; if it is 1, all fish have come into contact with the panel, if
 133 it is 0, none have. This leads to the following model for $e_{panel}(l)$:

$$134 \quad e_{panel}(l) = C_{panel} \times (1 - rc_{panel}(l, \mathbf{v}_{panel})) \quad (2)$$

135 where $rc_{panel}(l, \mathbf{v}_{panel})$ is the selection model for fish making contact with the panel and having
 136 a suitable orientation to achieve a size-dependent probability of passing through the panel
 137 mesh, and $\mathbf{v}_{panel}$ are the parameters of model $rc_{panel}(l, \mathbf{v}_{panel})$. A further assumption is that the
 138 probability $rc_{panel}(l, \mathbf{v}_{panel})$ can be described by standard ‘S-shaped’ size selection models for

trawl gears. We considered four ‘S-shaped’ size selection curves: *Logit*, *Probit*, *Gompertz*, and *Richards*. Further information on these functions, their respective parameters $\mathbf{v}$ and the calculation of the selectivity parameters L_{50} and SR ($L_{75} - L_{25}$) can be found in Wileman et al. (1996).

To obtain the size-dependent codend retention probability $rc_{codend}(l, \mathbf{v}_{codend})$, it was assumed that every fish entering the codend came into contact with the codend meshes and that $rc_{codend}(l, \mathbf{v}_{codend})$, like $rc_{panel}(l, \mathbf{v}_{panel})$, could be modelled by the *Logit*, *Probit*, *Gompertz*, or *Richards* model. Calculation of codend escapement involves the fish that have not escaped through the panel. The above considerations lead to the following model for $e_{codend}(l)$:

$$e_{codend}(l) = (1 - rc_{codend}(l, \mathbf{v}_{codend})) \times (1 - e_{panel}(l, C_{panel}, \mathbf{v}_{panel})) \quad (3)$$

Model estimation and model selection

The values of parameters C_{panel} , $\mathbf{v}_{panel}$ and $\mathbf{v}_{codend}$ for selection models (1)-(3) are species-specific and were obtained using Maximum Likelihood Estimation (MLE) by pooling the experimental data over hauls j (1 to m) and minimising:

$$-\sum_l \left\{ \sum_{j=1}^m \left[\frac{nCD_{lj}}{qCD_{lj}} \right] \times \ln(r_{comb}(l, C_{panel}, \mathbf{v}_{panel}, \mathbf{v}_{codend})) + \sum_{j=1}^m \left[\frac{nPC_{lj}}{qPC_{lj}} \right] \times \ln(e_{panel}(l, C_{panel}, \mathbf{v}_{panel})) + \sum_{j=1}^m \left[\frac{nCC_{lj}}{qCC_{lj}} \right] \times \ln(e_{codend}(l, C_{panel}, \mathbf{v}_{panel}, \mathbf{v}_{codend})) \right\} \quad (4)$$

where for each haul j and length class l , nCD_{lj} , nPC_{lj} and nCC_{lj} are the numbers of individuals measured in the CD, PC, and CC, respectively, and qCD_{lj} , qPC_{lj} and qCC_{lj} are their respective sampling factors (ratio of measured to total number of fish in each compartment). Altogether, 16 models were considered to describe overall trawl size selectivity based on the combination of the four S-shaped functions considered for $rc_{panel}(l)$ and $rc_{codend}(l)$. The 16 models were tested against each other based on their AIC values (Akaike 1974), and the one with the lowest value was selected. Maximum Likelihood

161 Estimation using equations (4) with (1) to (3) require pooling the experimental data over
162 hauls. This results in stronger data for average size selectivity estimation, at the expense of
163 not considering explicit variation in selectivity between hauls (Fryer 1991). To account
164 correctly for the effect of between-haul variation in estimating uncertainty in size selection, a
165 double bootstrap method was used to calculate the 95 % Efron percentile confidence intervals
166 (95 % CIs) for the parameters in equations (1) - (3) and for the resulting $e_{panel}(l)$, $e_{codend}(l)$ and
167 $r_{comb}(l)$ curves. SELNET software (Herrmann et al. 2012) was used for the analysis and 1000
168 bootstrap iterations were applied to estimate the 95 % CIs.

169 The models were validated based on p-value and model deviance versus degrees of freedom
170 (Wileman et al. 1996). Where p-values were < 0.05 and deviance $\gg$ degrees of freedom, the
171 residuals were inspected to determine whether the discrepancy between model and
172 experimental data was the result of overdispersion.

173 *Combined vs. codend only selectivity*

174 The selection curves of the combined (panel + codend) and codend-only gear and their
175 respective CI were plotted for each species to establish whether the CIs overlapped, to
176 determine if there is a significant difference in selectivity between the gears.

177 **Results**

178 Eight hauls were performed during the study (Table 1). To ensure similar trawl geometry
179 from one haul to another, headline height and wingend spread were held near 0.8 ± 0.1 m and
180 18.5 ± 0.8 m, respectively, while the door distance was kept as close as possible to 70 m (± 7
181 m) by justifying the warp length. The average water depth and towing speed during the
182 experiment were 100 ± 7 m and 3.4 ± 0.2 knots, respectively. The net performance was
183 constantly monitored with the SIMRAD PI50 catch monitoring system.

184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206
207
208

Table 1.

The two covers enabled separate collection and measurement of the individuals retained by the codend (CD), codend cover (CC) and panel cover (PC) per haul and length class (Figure 2). When total catches were large in the codend and in the codend cover, a subsample was measured, while catches of the panel cover were never subsampled.

The most abundant species, deep-water rose shrimp (Table A1 on the Appendix), included 7,450 individuals, 5,710 in the CD, 1,591 in the CC, and 149 in the PC. The second most abundant species was poor cod (2,649 individuals), whose 1,234 were found in the CD and 1,369 in the CC, and only 46 in the PC. Atlantic horse mackerel ranked third, with the majority of the 2,135 individuals being found in the CC (1,256), compared with the CD (767) and the PC (112). Only 515 individuals of European hake were caught, 203 in the CD, 308 in the CC, and 4 in the PC. The least abundant species was broadtail shortfin squid, with a single individual found in the PC.

The modelling data are reported in Table 2, Figure 3 and Figure 4. The model p-values were < 0.05 for all species except poor cod, but given the lack of systematic patterns in residuals, the discrepancy between the data and the model is probably due to overdispersion (Wileman et al. 1996). The 95 % CIs of the escapement curves were always wider in the panel than in the codend (Figure 3 and Figure 4).

Table 2.
Figure 3.
Figure 4.

209 The average C_{panel} value was lowest for European hake and poor cod, entailing that only 2 %
210 of the individuals of these species had come into contact with the panel. Its relatively narrow
211 95 % CI demonstrates the low contact probability of the two species (Table 2). The average
212 contact probability with the panel, estimated for red mullet and broadtail shortfin squid, was
213 also very low, 6 % and 4 % respectively. However, the very broad 95 % CIs prevented
214 drawing any conclusion for this parameter in these species (Table 2). The average contact
215 probability estimated for deep-water rose shrimp was slightly higher than that of European
216 hake and poor cod (Table 2). The highest contact probability was estimated for Atlantic horse
217 mackerel, whose 95 % CI were much greater than those of European hake, poor cod, and
218 deep-water rose shrimp, but not as wide as those of red mullet and broadtail shortfin squid
219 (Table 2). The Minimum Conservation Reference Size (MCRS) is 15 cm for Atlantic horse
220 mackerel, 20 cm for European hake, 11 cm for red mullet, and 20 mm (carapace length) for
221 deep-water rose shrimp (Council Regulation (EC) No. 1967/2006). The other species
222 included in the study are not subject to MCRS requirements. The average $L50_{panel}$ value was
223 significantly different from the MCRS only for European hake and deep-water rose shrimp
224 (Table 2). Structural modelling enabled comparison of gear selectivity with and without the
225 selection panel. The results showed that the panel did not significantly affect overall gear
226 selectivity for any of the species analysed (Figure 5), further highlighting the poor release
227 efficiency of the square-mesh panel, due to the low contact probability estimated for all the
228 species investigated.

Figure 5.

230 Discussion

231 In this study, a model was applied to investigate the release efficiency of a 51.6 mm square-
232 mesh panel placed in front of the 51.9 mm diamond-mesh codend in a typical Mediterranean

233 bottom trawl. The model was able to capture the different behaviour of each fish species
234 found in the gear by taking into account that not all fish necessarily come into contact with
235 the panel meshes.

236 The present data clearly demonstrate that a trawl net equipped with a 51.6 mm square-mesh
237 panel mounted in the upper panel of the last tapered section of the trawl belly, just before the
238 51.9 mm diamond-mesh codend, is not more selective than a typical Mediterranean bottom
239 trawl without the panel. According to Wardle (1993), fish exhausted from swimming in front
240 of the trawl are guided down the funnel and do not make contact with the netting. Fish will
241 attempt to escape through the surrounding meshes of the extension only if their clearer path
242 to the codend is blocked (Glass et al. 1993). The results show that this was not the case in the
243 test gear, as reflected by the low average values of C_{panel} obtained for most species, which
244 never exceeded 9 %; these findings suggest that only a small proportion of the fish came into
245 contact with the panel. Very similar results were obtained by Alzorriz et al. (2016) in the
246 Basque bottom trawl fishery, where contact probability was as low as 1 % for hake and red
247 mullet, and 15 % for pouting (*Trisopterus luscus* and *Trisopterus minutus*). The poor contact
248 probability is likely due to the excessive distance of the panel from the codline (Herrmann et
249 al. 2015), a part of the net where fish have no reason to change direction and swim up
250 through the panel meshes. This could be changed by placing stimulation devices in the
251 vicinity of the square-mesh panel to alter swimming patterns, forcing fish to interact with the
252 panel meshes (Brewer et al. 1998; Eayrs 2007; Glass et al. 1995; Herrmann et al. 2015; Krag
253 et al. 2016; Grimaldo et al. 2017).

254 In this study a square-mesh panel inserted in front of the trawl failed to improve size and
255 species selection; as a result, the present findings are to all effects negative. However,
256 reporting this type of results does have a value both from the scientific and the fishery
257 management viewpoint, because they enhance our understanding of fishing gear selectivity

258 besides reducing the risk of testing the same non-functioning concepts several times. In
259 addition, publishing negative as well as favourable results prevents forming a biased picture
260 (Csada et al. 1996). Therefore, even though the proposed solution did not deliver the wanted
261 gain in size selectivity, we feel it still provides a useful contribution to the literature.

262 This noted, some caveats are in order. In fact, the present results are based on only eight hauls
263 and on a limited number of length measurements (Table A1). This leaves some uncertainty as
264 to the estimated size selection curves, and must to be taken into consideration when drawing
265 conclusions. However, since the uncertainties are reflected in the confidence bands around
266 the size selection curves and the parameters that are provided with the results, the limited
267 number of fish caught and measured in the study should not be a major concern if the
268 confidence bands are considered when drawing the conclusions.

269 Of the several works that have addressed the selectivity of 50 mm diamond-mesh codends in
270 the Mediterranean (Aydin et al. 2011; Gorelli et al. 2014; Sala and Lucchetti 2011; Sala et al.
271 2015; Tokaç et al. 2014; Tosunoğlu et al. 2008), only the study by Sala and co-workers
272 examined the selectivity of the 50 mm square-mesh codend (Sala et al. 2015). The studies
273 comparing the selectivity of 40 mm diamond-mesh and 40 mm square-mesh codends (Aydin
274 et al. 2011; Bahamon et al. 2006; Guijarro and Massuti 2006; Ordines et al. 2006; Petrakis
275 and Stergiou 1997; Sala et al. 2008; 2015; Stergiou et al. 1997) had led us to expect higher
276 L_{50} values for the panel than for the codend, whereas this was actually true only for deep-
277 water rose shrimp.

278 In the case of European hake and deep-water rose shrimp, the average $L_{50_{panel}}$ was
279 significantly smaller than the MCRS, suggesting that not all undersized individuals that came
280 into contact with the panel managed to escape through the panel meshes.

281 According to the new CFP, discards should be reduced through landing obligations and
282 improvements in gear selectivity (Regulation (EU) No. 1380/2013). In the Mediterranean

Sea, only species subject to the MCRS, included in Annex III of Council Regulation (EC) No. 1967/2006, are under landing obligations. Several studies show that no single measure can ensure “perfect selectivity” for all Mediterranean target species (Petrakis and Stergiou 1997; Sala et al. 2008), and that improvements in size and species selectivity can be achieved only through the simultaneous modification of multiple trawl features, including the panel.

Acknowledgements

This study was partially funded by the Interreg research project MARTE+ and the EU-FP7 project “BENTHIS” (grant agreement no. 312088). The authors are grateful to Word Designs (www.silviamodena.com) for the language revision and to Francesco De Carlo (CIBM, Italy) for his help in the fieldwork. We gratefully acknowledge the critical comments of the editor and the reviewers, which we feel have greatly improved our manuscript.

References

- Akaike, H. 1974. A new look at the statistical model identification. *IEEE Trans. Autom. Control.* **19**: 716-723.
- Alzorriz, N., Arregi, L., Herrmann, B., Sistiaga, M., Casey, J., Poos, J.J. 2016. Questioning the effectiveness of technical measures implemented by the Basque bottom otter trawl fleet: Implications under the EU landing obligation. *Fish. Res.* **175**: 116-126.
- Aydin, C., Tokaç, A., Ulaş, A., Maktay, B., Şensurat, T. 2011. Selectivity of 40 mm square and 50 mm diamond mesh codends for five species in the Eastern Mediterranean demersal trawl fishery. *Afr. J. Biotechnol.* **10**: 5037-5047.
- Bahamon, N., Sardà, F., Suuronen, P. 2006. Improvement of trawl selectivity in the NW Mediterranean demersal fishery by using a 40 mm square mesh codend. *Fish. Res.* **81**: 15-25.
- Brčić, J., Herrmann, B., De Carlo, F., Sala, A. 2015. Selective characteristics of a shark-excluding grid device in a Mediterranean trawl. *Fish. Res.* **172**: 352-360.
- Brewer, D., Rawlinson, N., Eayrs, S., Burrige, C. 1998. An assessment of Bycatch Reduction Devices in a tropical Australian prawn trawl fishery. *Fish. Res.* **36**: 195-215.
- Council Regulation (EC) No. 1967/2006 of 21 December 2006, concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea,

- 311 amending Regulation (EC) No. 2847/93 and repealing Regulation (EC) No. 1626/94. Official
312 Journal of the European Union L. 409.
- 313 Council Regulation (EC) No. 517/2008 of 10 June 2008 laying down detailed rules for the
314 implementation of Council Regulation (EC) No. 850/98 as regards the determination of the
315 mesh size and assessing the thickness of twine of fishing nets. Official Journal of the
316 European Union L 151.
- 317 Csada, R.D., James, P.C., Richard, H.M.E. 1996. The "File Drawer Problem" of Non-
318 Significant Results: Does It Apply to Biological Research? *Oikos* **76**: 591-593.
- 319 Damalas, D., Maravelias, C.D., Osio, G.C., Maynou, F., Sbrana, M., Sartor, P., Casey, J.
320 2015. Historical discarding in Mediterranean fisheries: a fishers' perception. *ICES J. Mar.*
321 *Sci.* **72**: 2600-2608.
- 322 Eayrs, S. 2007. A Guide to Bycatch Reduction in Tropical Shrimp-Trawl Fisheries. FAO,
323 Rome.
- 324 Eigaard, O.R., Rihan, D., Graham, N., Sala, A., Zachariassen, K. 2011. Improving fishing
325 effort descriptors: Modelling engine power and gear-size relations of five European trawl
326 fleets. *Fish. Res.* **110**: 39-46.
- 327 Fiorentini, L., Dremière, P.Y., Leonori, I., Sala, A., Palumbo, V. 1999. Efficiency of the
328 bottom trawl used for the Mediterranean International Trawl Survey (MEDITS). *Aquat.*
329 *Living Res.* **12(3)**: 187-205.
- 330 Fiorentini, L., Sala, A., Hansen, K., Cosimi, G., Palumbo, V. 2004. Comparison between
331 model testing and full-scale trials of new trawl design for Italian bottom fisheries. *Fish. Sci.*
332 **70**: 349-359.
- 333 Fryer, R. 1991. A model of the between-haul variation in selectivity. *ICES J. Mar. Sci.* **48**:
334 281-290.
- 335 Glass, C.W., Wardle, C.S., Gosden, S.J. 1993. Behavioural studies of the principles
336 underlying mesh penetration by fish. *ICES Mar. Sci. Symp.* **196**: 92-97.
- 337 Glass, C.W., Wardle, C.S., Gosden, S.J., Racey, D.N. 1995. Studies on the use of visual
338 stimuli to control fish escape from codends. I. Laboratory studies on the effect of a black
339 tunnel on mesh penetration. *Fish. Res.* **23**: 157-164.
- 340 Gorelli, G., Company, J.B., Sardà, F. 2014. Management strategies for the fishery of the red
341 shrimp *Aristeus antennatus* in Catalonia (NE Spain), Marine Stewardship Council Science
342 Series **2**: 116-127.
- 343 Graham, N., Kynoch, R.J. 2001. Square mesh panels in demersal trawls: some data on
344 haddock selectivity in relation to mesh size and position. *Fish. Res.* **49**: 207-218.
- 345 Graham, N., Kynoch, R.J., Fryer, R.J. 2003. Square mesh panels in demersal trawls: further
346 data relating haddock and whiting selectivity to panel position. *Fish. Res.* **62**: 361-375.
- 347 Grimaldo, E., Sistiaga, M., Herrmann, B., Larsen, R.B., Brinkhof, J., Tatone, I. 2017.
348 Improving release efficiency of cod (*Gadus morhua*) and haddock (*Melanogrammus*
349 *aeglefinus*) in the Barents Sea demersal trawl fishery by stimulating escape behaviour.
350 *Canadian Journal of Fisheries and Aquatic Sciences* (DOI: 10.1139/cjfas-2017-0002).
- 351 Guijarro, B., Massuti, E. 2006. Selectivity of diamond- and square-mesh codends in the
352 deepwater crustacean trawl fishery off the Balearic Islands (western Mediterranean). *ICES J.*
353 *Mar. Sci.* **63**: 52-67.

- 354 Herrmann, B., Krag, L.A., Frandsen, R.P., Madsen, N., Lundgren, B., Stæhr, K.J. 2009.
 355 Prediction of selectivity from morphological conditions: methodology and a case study on
 356 cod (*Gadus morhua*). Fish. Res. **97**: 59-71.
- 357 Herrmann, B., Sistiaga, M., Nielsen, K.N., Larsen, R.B. 2012. Understanding the size
 358 selectivity of redfish (*Sebastes* spp.) in North Atlantic trawl codends. J. Northwest Atl. Fish.
 359 Sci. **44**: 1-13.
- 360 Herrmann, B., Wienbeck, H., Karlsen, J.D., Stepputtis, D., Dahm, E., Moderhak, W. 2015.
 361 Understanding the release efficiency of Atlantic cod (*Gadus morhua*) from trawls with a
 362 square mesh panel: effects of panel area, panel position, and stimulation of escape response.
 363 ICES J. Mar. Sci. **72**: 686-696.
- 364 Kaykac, H. 2010. Size selectivity of commercial (300 MC) and larger square mesh top panel
 365 (LSMTPC) trawl codends for blue whiting (*Micromesistius poutassou* Risso, 1826) in the
 366 Aegean Sea. Afr. J. Biotechnol. **9**: 9037-9041.
- 367 Krag, L.A., Herrmann, B., Feekings, J., Lund, H.S., Karlsen, J.D. 2016. Improving escape
 368 panel selectivity in Nephrops-directed fisheries by actively stimulating fish behavior. Can. J.
 369 Fish. Aquat. Sci. **74**: 486-493.
- 370 Metin, C., Özbilgin, H., Tosunoğlu, Z., Gökçe, G., Aydin, C., Metin, G., Ulaş, A., Kaykaç,
 371 H., Lök, A., Düzbastılar, F.O., Tokaç, A. 2005. Effect of square mesh escape window on
 372 codend selectivity for three fish species in the Aegean Sea. Turk. J. Vet. Anim. Sci. **29**: 461-
 373 468.
- 374 Notti, E., De Carlo, F., Brčić, J., Sala, A. 2013. Technical specifications of Mediterranean
 375 trawl gears, in: Paschen, M. (Ed.), Proceedings of the 11th International Workshop on
 376 methods for the development and evaluation of maritime technologies, Contributions on the
 377 Theory of Fishing Gears and Related Marine Systems Vol. 8. Proceedings of the 11th
 378 International Workshop on methods for the development and evaluation of maritime
 379 technologies, Rostock. pp. 163-169. ed. Shaker Verlag GmbH, Rostock, p. 310.
- 380 Ordines, F., Massutí, E., Guijarro, B., Mas, R. 2006. Diamond vs. square mesh codend in a
 381 multi-species trawl fishery of the western Mediterranean: effects on catch composition, yield,
 382 size selectivity and discards. Aquat. Living Resour. **19**: 329-338.
- 383 Özbilgin, H., Tosunoglu, Z., Aydin, C., Kaykac, H., Tokac, A. 2005. Selectivity of standard,
 384 narrow and square mesh panel trawl codends for hake (*Merluccius merluccius*) and poor cod
 385 (*Trisopterus minutus capelanus*). Turk. J. Vet. Anim. Sci. **29**: 967-973.
- 386 Petrakis, G., Stergiou, K. 1997. Size selectivity of diamond and square mesh codends for four
 387 commercial Mediterranean fish species. ICES J. Mar. Sci. **54**: 13-23.
- 388 Prat, J., Antonijuan J., Folch A., Sala, A., Lucchetti, A., Sardà F., Manuel A. 2008. A
 389 simplified model of the interaction of the trawl warps, the otterboards and netting drag. Fish.
 390 Res. **94**: 109-117.
- 391 Regulation (EU) No. 1380/2013, of the European Parliament and of the Council of 11
 392 December 2013 on the Common Fisheries Policy, amending Council Regulations (EC) No.
 393 1954/2003 and (EC) No 1224/2009 and repealing Council Regulations (EC) No. 2371/2002
 394 and (EC) No 639/2004 and Council Decision 2004/585/EC. Official Journal of the European
 395 Union L 354.
- 396 Sala, A., Priour, D., Herrmann, B. 2006. Experimental and theoretical study of red mullet
 397 (*Mullus barbatus*) selection in codends of Mediterranean bottom trawls. Aquat. Living
 398 Resour. **19**: 317-327.

- 399 Sala, A., Lucchetti, A., Piccinetti, C., Ferretti, M. 2008. Size selection by diamond- and
400 square-mesh codends in multi-species Mediterranean demersal trawl fisheries. *Fish. Res.* **93**:
401 8-21.
- 402 Sala, A., Prat, J., Antonijuan, J., Lucchetti, A. 2009. Performance and impact on the seabed
403 of an existing- and an experimental-otterboard: Comparison between model testing and full-
404 scale sea trials. *Fish. Res.* **100**: 156-166.
- 405 Sala, A., Lucchetti, A. 2010. The effect of mesh configuration and codend circumference on
406 selectivity in the Mediterranean trawl *Nephrops* fishery. *Fish. Res.* **103**: 63-72.
- 407 Sala, A., Lucchetti, A. 2011. Effect of mesh size and codend circumference on selectivity in
408 the Mediterranean demersal trawl fisheries. *Fish. Res.* **110**: 252-258.
- 409 Sala, A., Lucchetti, A., Perdichizzi, A., Herrmann, B., Rinelli, P. 2015. Is square-mesh better
410 selective than larger mesh? A perspective on the management for Mediterranean trawl
411 fisheries. *Fish. Res.* **161**: 182-190.
- 412 SEAFISH, IFREMER, DIFTA 1993. Otterboard performance and behaviour. Commission of
413 the European Communities FAR, 159 pp.
- 414 Stergiou, K.I., Petrakis, G., Politou, C.Y. 1997. Size selectivity of diamond and square mesh
415 cod-ends for *Nephrops norvegicus* in the Aegean Sea. *Fish. Res.* **29**: 203-209.
- 416 Stewart, P.A.M., Robertson, J.H.B. 1985. Small mesh covers. *Scot. Fish. Res. Rep.*, **32**.
- 417 Suuronen, P., Sardà, F. 2007. By-catch reduction techniques in European fisheries:
418 Traditional methods and potential innovations, in: Kennelly, S.J. (Ed.), By-catch reduction in
419 the world's fisheries. Springer, Dordrecht, pp. 37-74.
- 420 Tokaç, A., Özbilgin, H., Kaykaç, H. 2009. Alternative codend designs to improve size
421 selectivity for Norway lobster (*Nephrops norvegicus*) and rose shrimp (*Parapenaeus*
422 *longirostris*) in the Aegean Sea. *Crustaceana* **82**: 689-702.
- 423 Tokaç, A., Özbilgin, H., Kaykaç, H. 2010. Selectivity of conventional and alternative codend
424 design for five fish species in the Aegean Sea. *J. Appl. Ichthyol.* **26**: 403-409.
- 425 Tokaç, A., Herrmann, B., Aydın, C., Kaykaç, H., Ünlüler, A., Gökçe, G. 2014. Predictive
426 models and comparison of the selectivity of standard (T0) and turned mesh (T90) codends for
427 three species in the Eastern Mediterranean. *Fish. Res.* **150**: 76-88.
- 428 Tosunoğlu, Z., Aydın, C., Özaydın, O. 2008. Selectivity of a 50-mm diamond mesh knotless
429 polyethylene codend for commercially important fish species in the Aegean Sea. *J. Appl.*
430 *Ichthyol.* **24**: 311-315.
- 431 Tsagarakis, K., Palialexis, A., Vassilopoulou, V. 2014. Mediterranean fishery discards:
432 review of the existing knowledge. *ICES J. Mar. Sci.* **71**: 1219-1234.
- 433 Wardle, C.S. 1993. Fish behaviour and fishing gear, in: Pitcher, T.J. (Ed.), Behaviour of
434 Teleost Fishes. Chapman and Hall, London, pp. 463-495.
- 435 Wileman, D., Ferro, R.S.T., Fonteyne, R., Millar, R.B. 1996. Manual of methods of
436 measuring the selectivity of towed fishing gears, ICES Cooperative Research Report No.
437 215., p. 132.

1 Table 1. Summary of the selectivity hauls conducted in the Tyrrhenian Sea. TS: trawl speed; HNO: horizontal net opening; VNO: vertical net
2 opening; HDS: horizontal door spread. PC: panel cover, CC: codend cover, CD: codend, SD: standard deviation.

Shooting time			Depth	TS	HNO	VNO	HDS	Catch [kg]		
Start	End	Duration						PC	CC	CD
09:35	11:15	01:40	96	3.4	17.0	0.80	65.7	1.00	11.84	44.13
11:55	13:40	01:45	107	3.4	19.8	0.90	74.6	1.01	8.74	47.88
14:05	15:45	01:40	108	3.4	18.7	0.80	71.0	0.48	11.23	38.76
16:05	17:41	01:36	91	3.4	18.1	0.90	69.2	1.06	15.80	60.12
09:23	11:04	01:41	90	3.4	18.9	0.60	73.2	1.99	17.98	56.32
11:46	13:35	01:49	103	3.3	18.2	0.85	79.2	2.31	15.60	76.76
14:15	16:05	01:50	105	3.0	18.9	0.75	57.0	0.86	17.25	50.98
16:44	18:26	01:42	102	3.5	18.3	0.69	69.7	0.66	4.91	35.59
Mean		01:42	100	3.4	18.5	0.79	69.9	1.17	12.92	51.32
SD		00:04	7	0.2	0.8	0.10	6.6	0.64	4.56	13.19

Table 2. Average selectivity results and 95% confidence intervals (in brackets) for all the species in the experiment. TT: Atlantic horse mackerel; MM: European hake; MB: red mullet; TM: poor cod; IC: broadtail shortfin squid; PL: deep-water rose shrimp; For broadtail shortfin squid, L50 and SR values refer to mantle length in cm; for deep-water rose shrimp, MCRS (minimum conservation reference size), L50 (50% retention probability) and SR values (selection range = L75-L25) refer to carapace length in mm; for all other species MCRS, L50 and SR values refer to total length in cm. DOF: degrees of freedom. $1/\delta$: asymmetry parameter of the Richard's curve; rc_{panel} : the best model used to describe the escapement probability through the panel; rc_{codend} : the best model used to describe codend retention probability.

	Species					
	TT	MM	MB	TM	IC	PL
rc_{panel}	Logit	Probit	Gompertz	Gompertz	Probit	Gompertz
rc_{codend}	Probit	Richard	Richard	Richard	Gompertz	Gompertz
C_{panel}	0.09	0.02	0.06	0.02	0.04	0.05
	(0.07-0.80)	(0.00-0.05)	(0.00-1.00)	(0.01-0.04)	(0.00-1.00)	(0.04-0.11)
L50	15.17	13.71	10.35	11.08	6.29	16.70
	(14.48-16.42)	(12.28-14.17)	(3.87-12.62)	(10.42-11.63)	(5.15-6.90)	(15.61-17.65)
SR	4.72	3.37	9.11	3.04	2.52	4.88
	(4.04-5.83)	(2.49-4.21)	(3.45-22.75)	(2.43-3.84)	(1.18-4.05)	(4.15-5.54)
$L50_{panel}$	12.74	10.32	4.26	14.21	4.41	20.20
	(0.24-15.22)	(0.07-12.45)	(0.32-17.17)	(11.49-17.16)	(0.07-4.71)	(18.20-21.76)
SR_{panel}	2.49	2.29	3.72	2.14	1.00	3.11
	(1.00-7.99)	(1.00-2.68)	(1.00-4.79)	(1.00-6.30)	(1.00-1.00)	(1.86-4.19)
$L50_{codend}$	15.06	13.71	9.81	11.02	6.29	16.47
	(14.36-16.38)	(12.28-14.17)	(2.95-12.50)	(10.31-11.60)	(5.15-6.90)	(15.26-17.47)
SR_{codend}	4.88	3.38	11.02	2.98	2.52	4.63
	(4.14-6.07)	(2.50-4.22)	(3.60-22.70)	(2.40-3.72)	(1.18-4.05)	(3.88-5.29)
$1/\delta$	-	0.15	0.10	4.23	-	-
		(0.12-1.01)	(0.10-0.70)	(0.98-10.00)		
MCRS	15	20	11	-	-	20

	Species					
	TT	MM	MB	TM	IC	PL
p-value	0.751	1.000	0.679	0.039	1.000	0.162
DOF	99	104	50	68	61	51
Deviance	89.15	51.88	44.87	89.95	26.94	60.89

12

13

Draft

Figure 1. Main details of the gear rigging adopted during the sea trials.

Draft

Figure 2. Illustration of the panel-based dual selection system used in the current study. The two covers enabled separate collection and measurement of all the individuals retained by the codend (CD), codend cover (CC) and panel cover (PC). The square-mesh panel (SMP) was made of a polyamide netting (mesh size 51.6 mm) mounted in the upper part of the last tapered section of the trawl belly (a), 8 m from the codline and 2 m from the codend. The mesh number (Mesh No.) of a diamond mesh netting refers to the number of stretched meshes, while the mesh number in the square-mesh panel refers to the number of mesh bars.

14

15 Figure 3. Probability of escaping through the panel, of escaping from the codend and of being
16 retained in the codend for *T. trachurus* (TT), *M. merluccius* (MM) and *M. barbatus* (MB). Black
17 solid circles: average experimental rates per size class. Black solid curves: dual selection models
18 fitted to the experimental data. Dashed black curves: 95 % confidence bands for the fitted models.
19 Solid grey curves: structure of the population that was retained in each compartment. Vertical grey
20 dashed line: Minimum Conservation Reference Size.

Figure 4. Probability of escaping through the panel, of escaping from the codend and of being retained in the codend for *T. minutus* (TM), *I. coindetii* (IC) and *P. longirostris* (PL). Black solid circles represent average experimental rates per size class. Black solid curves: dual selection models fitted to the experimental data. Dashed black curves: 95 % confidence bands for the fitted models. Solid grey curves: structure of the population that was retained in each compartment. Vertical grey dashed line: Minimum Conservation Reference Size.

Figure 5. Comparison between combined (panel + codend) and simulated codend-only selection for *T. trachurus* (TT), *M. merluccius* (MM) and *M. barbatus* (MB), *T. minutus* (TM), *I. coindetii* (IC), and *P. longirostris* (PL). Black solid line: combined retention curve (panel + codend); dotted black lines: 95 % confidence bands for the combined retention curves; solid grey line: codend retention curve; dotted grey lines: 95 % confidence bands for codend retention curves; dashed black line: structure of the population that entered the gear; vertical grey dashed line: Minimum Conservation Reference Size.

Table A1. Number of individuals measured (n) subsampling ratio (q) and minimum and maximum length for every species, caught in each compartment (Comp). CD: codend; PC: panel cover; CC: codend cover); TT: Atlantic horse mackerel; MM: European hake; MB: red mullet; TM: poor cod; IC: broadtail shortfin squid; PL: deep-water rose shrimp. For broadtail shortfin squid, minimum and maximum length values refer to mantle length in cm, for deep-water rose shrimp values refer to carapace length in mm; for all the other species values refer to total length in cm.

Species	Comp	Haul								
			1	2	3	4	5	6	7	8
TT	PC	(n)	(2)	(1)	(1)	(2)	(94)	(7)	(1)	(4)
		(q)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		min-max length (cm)	15.5 16.0	14.5 14.5	17.5 17.5	14.5 18.0	6.0 12.0	6.0 10.5	5.5 5.5	6.5 10.5
	CC	(n)	(60)	(22)	(19)	(73)	(312)	(38)	(4)	(8)
		(q)	(1)	(1)	(1)	(1)	(0.33)	(0.33)	(0.25)	(0.50)
		min-max length (cm)	13.0 21.0	14.0 21.0	16.0 21.0	14.5 20.5	5.5 18.0	5.0 17.5	5.5 14.5	5.0 9.5
	CD	(n)	(67)	(106)	(105)	(95)	(70)	(28)	(9)	(2)
		(q)	(1)	(1)	(1)	(0.25)	(1)	(1)	(1)	(1)
		min-max length (cm)	13.0 22.0	12.0 36.5	15.0 36.0	14.5 32.0	7.0 26.5	7.5 23.0	15.0 31.0	16.5 16.5
MM	PC	(n)	(2)	(0)	(0)	(0)	(0)	(0)	(2)	(0)
		(q)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		min-max length (cm)	6.5 7.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	8.5 11.5	0.0 0.0
	CC	(n)	(60)	(13)	(3)	(12)	(20)	(26)	(18)	(5)
		(q)	(1)	(1)	(1)	(1)	(0.33)	(0.33)	(0.25)	(0.50)
		min-max length (cm)	4.5 14.0	5.0 12.5	5.0 13.5	5.0 15.0	7.0 14.0	7.0 14.0	8.0 13.5	8.0 13.5
	CD	(n)	(28)	(22)	(16)	(27)	(34)	(38)	(23)	(15)
		(q)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		min-max length (cm)	6.0 30.0	12.0 39.0	10.0 31.5	12.5 36.0	9.5 35	10.0 40.0	11.0 32.0	9.5 24.5
MB	PC	(n)	(1)	(1)	(0)	(0)	(0)	(0)	(0)	(1)
		(q)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		min-max length (cm)	12.0 12.0	9.5 9.5	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	16.0 16.0
	CC	(n)	(4)	(9)	(1)	(3)	(4)	(5)	(0)	(0)
		(q)	(1)	(1)	(1)	(1)	(0.33)	(0.33)	(1)	(1)
		min-max length (cm)	10.5 15.5	9.0 16.0	15.0 15.0	12.5 13.0	12.5 13.5	11.5 16.5	0.0 0.0	0.0 0.0
	CD	(n)	(8)	(27)	(32)	(5)	(28)	(27)	(59)	(6)
		(q)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		min-max length (cm)	10.0 21.0	9.5 23.5	9.5 23.5	10.5 16.5	12.0 19.5	12.0 22.0	12.0 23.0	12.5 23.0
TM	PC	(n)	(5)	(13)	(7)	(4)	(3)	(7)	(3)	(4)
		(q)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		min-max length (cm)	11.0 12.0	10.5 14.0	9.5 16.0	11.5 13.0	5.0 8.5	6.5 14.5	7.0 7.5	6.5 7.5
	CC	(n)	(19)	(72)	(89)	(91)	(50)	(110)	(116)	(41)
		(q)	(1)	(0.50)	(1)	(1)	(0.33)	(0.33)	(0.25)	(0.50)
		min-max length (cm)	10.0 14.0	9.5 15.0	9.0 15.0	9.0 14.5	4.0 14.0	5.0 14.0	4.5 16.0	4.5 16.0

			Haul							
Species	Comp		1	2	3	4	5	6	7	8
IC	CD	(n)	(144)	(147)	(115)	(81)	(52)	(64)	(74)	(88)
		(q)	(1)	(0.50)	(0.50)	(0.50)	(0.50)	(1)	(0.50)	(1)
		min-max	10.0	9.0	9.0	10.0	7.0	8.0	10.0	6.0
		length (cm)	23.0	20.0	18.0	21.0	20.0	22.5	19.0	20
	PC	(n)	(0)	(0)	(0)	(0)	(0)	(0)	(1)	(0)
		(q)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		min-max	0.0	0.0	0.0	0.0	0.0	0.0	4.5	0.0
		length (cm)	0.0	0.0	0.0	0.0	0.0	0.0	4.5	0.0
	CC	(n)	(3)	(6)	(4)	(0)	(11)	(16)	(12)	(4)
		(q)	(1)	(1)	(1)	(1)	(0.33)	(0.33)	(0.25)	(0.50)
		min-max	3.5	5.5	5.0	0.0	3.0	3.5	4.0	5.0
		length (cm)	5.0	9.5	9.0	0.0	9.5	7.5	6.0	5.5
	CD	(n)	(4)	(18)	(20)	(19)	(68)	(29)	(60)	(47)
		(q)	(1)	(1)	(1)	(1)	(1)	(0.50)	(1)	(1)
		min-max	7.0	6.0	5.5	7.0	5.0	5.5	5.0	4.5
		length (cm)	13.5	18.5	19.0	18.0	18.5	18.0	19.0	17.5
PL	PC	(n)	(3)	(26)	(16)	(0)	(13)	(34)	(25)	(32)
		(q)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		min-max	10.0	14.0	11.0	0.0	11.0	13.0	11.0	8.0
		length (cm)	17.0	26.0	23.0	0.0	22.0	27.0	21.0	26.0
	CC	(n)	(23)	(86)	(95)	(36)	(63)	(182)	(132)	(44)
		(q)	(1)	(1)	(1)	(1)	(0.33)	(0.33)	(0.25)	(0.50)
		min-max	9.0	7.0	8.0	11.0	9.0	8.0	7.0	10.0
		length (cm)	24.0	26.0	27.0	26.0	26.0	28.0	28.0	26.0
	CD	(n)	(56)	(240)	(150)	(119)	(212)	(240)	(226)	(226)
		(q)	(1)	(0.25)	(0.25)	(0.50)	(0.33)	(0.25)	(0.17)	(0.25)
		min-max	16.0	13.0	16.0	17.0	13.0	15.0	12.0	14.0
		length (mm)	32.0	28.0	31.0	34.0	30.0	36.0	30.0	31.0