



Taenia solium in Europe

Still endemic?

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Taenia solium in Europe: still endemic?

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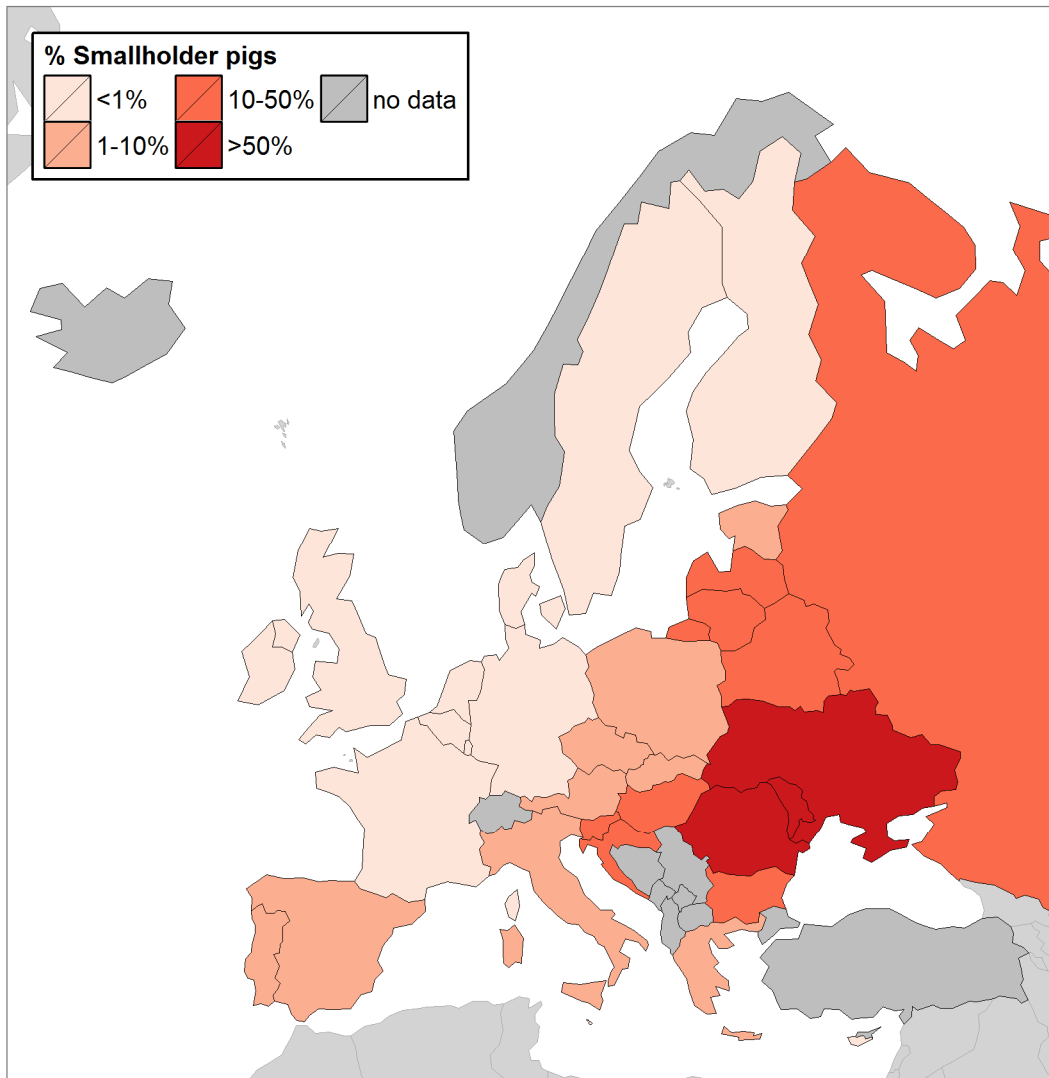
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Graphical abstract



This manuscript summarizes information on autochthonous human *Taenia solium* taeniosis/cysticercosis, porcine cysticercosis, and pig rearing conditions in Europe. There is considerable uncertainty about the true endemicity status of *T. solium* across Europe, but favourable conditions for *T. solium* transmission still exist in Eastern Europe.

Highlights

- There is considerable uncertainty regarding *Taenia solium* endemicity across Europe
- International literature is insufficient to assess situation in Eastern Europe
- Officially reported data on porcine cysticercosis are highly insufficient
- Favourable conditions for *T. solium* transmission still exist in Eastern Europe

Acta Tropica—Special Issue on the Fate of Neglected Zoonotic Diseases
Short Communication

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1 **Highlights**

- 2 • There is considerable uncertainty regarding *Taenia solium* endemicity across Europe
- 3 • International literature is insufficient to assess situation in Eastern Europe
- 4 • Officially reported data on porcine cysticercosis are highly insufficient
- 5 • Favourable conditions for *T. solium* transmission still exist in Eastern Europe

6

7 **Abstract**

8 The pork tapeworm *Taenia solium* causes an important economic and health burden, mainly in
9 rural or marginalized communities of sub-Saharan Africa, Asia and Latin-America. Although
10 improved pig rearing conditions seem to have eliminated the parasite in most Western European
11 countries, little is known about the true endemicity status of *T. solium* throughout Europe. Three
12 recent reviews indicate that autochthonous human *T. solium* taeniosis/cysticercosis may be
13 possible in Europe, but that current peer-reviewed literature is biased towards Western Europe.
14 Officially reported data on porcine cysticercosis are highly insufficient. Favourable conditions for
15 local *T. solium* transmission still exist in eastern parts of Europe, although the ongoing
16 integration of the European Union is speeding up modernisation and intensification of the pig
17 sector. Further evidence is urgently needed to fill the gaps on the European *T. solium* endemicity
18 map. We urge to make human cysticercosis notifiable and to improve the reporting of porcine
19 cysticercosis.

20 **Keywords**

21 Cysticercosis; Epidemiology; Europe; Neurocysticercosis; *Taenia solium*; Taeniosis.

22

23 **Introduction**

24 *Taenia solium*, the pork tapeworm, is a neglected zoonotic parasite causing cysticercosis in pigs
25 and taeniosis and cysticercosis in humans. In a recent ranking of parasitic diseases by the Food
26 and Agriculture Organization of the United Nations (FAO), *T. solium* cysticercosis was ranked
27 first, motivated by the economic impact of porcine cysticercosis and the health impact of human
28 neurocysticercosis-related epilepsy (FAO/WHO, 2014).

29 To maintain its lifecycle, *T. solium* requires non-industrialized pig rearing conditions,
30 consumption of undercooked pork, and low sanitation standards. As a result, *T. solium*
31 taeniosis/cysticercosis is mainly a problem in rural or marginalized communities of sub-Saharan
32 Africa, Asia, and Latin America. Nevertheless, three recent reviews concluded that the
33 prevalence of neurocysticercosis is also on the rise in Europe (Del Brutto, 2012; Fabiani and
34 Bruschi, 2013; Zammarchi et al., 2013). Although this is mainly due to increased migration and
35 travel, the authors also mention several autochthonous cases of neurocysticercosis. Such cases
36 may be the result of an imported *T. solium* tapeworm carrier, but also of local transmission,
37 raising questions about the true endemicity status of *T. solium* in Europe. Although human and
38 porcine cysticercosis were highly prevalent in Western Europe by the end of the nineteenth
39 century, improved pig rearing conditions following the end of World War I reduced the incidence
40 of cysticercosis considerably (Del Brutto, 2012). In Eastern Europe, on the other hand,
41 cysticercosis supposedly remained endemic throughout the twentieth century (Del Brutto, 2012).
42 However, there appears to be large uncertainties about these statements. Indeed, the latest *T.*
43 *solium* endemicity map of the World Health Organization shows that no data are available for
44 most Eastern European countries; most Western European countries show imported cases, but
45 with possible human cysticercosis transmission; and Spain, Portugal and Russia are suspected
46 endemic (WHO, 2015; Figure 1).

47 In this short communication, we aim to summarize what is known on the endemicity status of *T.*
48 *solium* in Europe, by reviewing information on autochthonous human *T. solium*
49 taeniosis/cysticercosis, porcine cysticercosis, and pig rearing conditions.

50

51 **Autochthonous human *Taenia solium* infection in Europe**

52 Three recent reviews summarized available literature on human *T. solium* taeniosis/cysticercosis
53 in Europe. **Del Brutto (2012)** performed a review of patients diagnosed with neurocysticercosis in
54 Western Europe between 1970 and 2011, and identified a total of 779 patients. Of the 371 cases
55 with available citizenship status information, European non-travellers accounted for 39%
56 (143/371). Compared to immigrants and travellers, these putative autochthonous cases were more
57 often diagnosed before 2000, older, and more likely to present with calcified cysts. **Fabiani and**
58 **Bruschi (2013)** reviewed European literature from 1970 onwards, and found 176 human
59 cysticercosis cases reported in 17 European countries. Of these cases, 20 were described as
60 autochthonous (including 14 in Italy, 5 in Germany and 1 in the United Kingdom). Eight other
61 cases originated from the former Yugoslavia, Turkey, Greece, Portugal, and Spain, but were
62 diagnosed in other European countries. Seven of these 28 cases were published in 2000 or later
63 (including 3 patients from Italy and 1 each from Germany, Greece, the former Yugoslavia and the
64 United Kingdom). **Zammarchi et al. (2013)** provided the most detailed assessment of possible
65 autochthonous human *T. solium* infection in Europe to date. In a review of papers published
66 between 1990 and 2011, they found 846 cysticercosis cases, of which 522 were described as
67 autochthonous. More than 90% of these cases originated from three countries: Portugal (70%),
68 Serbia (15%), and Spain (7%). The Portuguese cases were diagnosed in the 1980s and 1990s, but
69 information was lacking on the history of the Serbian and Spanish cases. In general,
70 autochthonous cases tended to be older and more likely to have calcified lesions, indicating that
71 infection might have been acquired in the past. **Zammarchi et al. (2013)** also identified 68
72 putative autochthonous *T. solium* taeniosis cases, reported in Poland (49), Albania (18), and Italy
73 (1). However, as these cases were not molecularly confirmed, at least some of these, could be
74 misdiagnosed cases of *Taenia saginata*, the beef tapeworm.

75 **Porcine cysticercosis in Europe**

76 Despite the import of live pigs from endemic countries or the chance of importing *T. solium*
77 taeniosis (**Zammarchi et al., 2013; Gabriël et al., 2015**), porcine cysticercosis would be a near
78 conclusive sign of *T. solium* endemicity and local transmission in Europe. We reviewed

79 information on porcine cysticercosis in Europe provided by the World Organisation for Animal
80 Health (OIE) and the European Food Safety Authority (EFSA), and searched PubMed for
81 additional peer-reviewed literature.

82 **Table 1** shows the number of "porcine cysticercosis" cases reported to OIE from 2005 onwards
83 (www.oie.int/wahis_2/public/wahid.php/Diseaseinformation/statusdetail). Several hundreds of
84 cases were reported from Bulgaria in 2005 and 2006, dropping to 3 in 2009. Sporadic outbreaks
85 were reported from Romania, Serbia (and Montenegro), Slovakia, Slovenia, and Spain. Other
86 countries reported no cases, or did not report data.

87 EFSA, in collaboration with the European Centre for Disease Prevention and Control, publishes
88 annual reports on trends and sources of zoonoses in the European Union (EU). Available volumes
89 span reporting years 2004 to 2013. In this period, only Belgium, Estonia and Sweden provided
90 any information on (bovine/porcine) cysticercosis, despite the fact that data should be available
91 from meat inspection at slaughter due to prescribed EU legislation (**BIOHAZ/AHAW, 2007**).
92 Only Estonia reported putative porcine cysticercosis cases: in 2006, 8 slaughtered pigs were
93 reported to have "*Taenia saginata* cysticerci" (sic) or "*Cysticercus tenuicollis*", i.e., *Taenia*
94 *hydatigena* cysticerci (**EFSA, 2008**), while in 2010, 38 slaughtered pigs were reported to have
95 "cysticerci", in addition to 41 with "*C. tenuicollis*" (**EFSA, 2012**). In 2010, EFSA assessed the
96 current disease situation of bovine and porcine cysticercosis in the then 25 EU member states
97 based on a survey of relevant national institutes (**Dorny et al., 2010**). Porcine cysticercosis cases
98 were reported from Austria (34 in 2007), Estonia (10 in 2006), Lithuania (113; year unspecified),
99 Poland (547,941; year unspecified) and Romania (around 50 in 2007). The remaining countries
100 either reported no cases or did not respond at all.

101 A PubMed search only yielded two publications published after 2000. In Lublin Province,
102 Poland, porcine cysticercosis was reported in 93 out of 1,577,370 pigs examined between 2005
103 and 2008 (**Kozłowska-Łój, 2011**), and in 150 out of 3,367,444 pigs examined between 2009 and
104 2012 (**Kozłowska-Łój and Łój-Maczulska, 2014**). Own ongoing research further identified 1
105 suspected *T. solium* cyst in 1217 pigs slaughtered in Estonia between February and April 2014
106 (**Åhlberg et al., 2015**).

107

108 Pig rearing conditions in Europe

109 Given the continued presence of *T. saginata* in most European countries (Dorny et al., 2009), we
110 argue that current meat inspection practices and sanitary levels in Europe are not sufficient to
111 interrupt the lifecycle of *Taenia* species. Pig rearing conditions are therefore believed to be the
112 main risk factor for *T. solium* transmission.

113 Eurostat provides information on the pig rearing sector in the EU (Marquer et al., 2014). In 2013,
114 the total number of pigs in the 28 EU member states was estimated at 146 million. Pig production
115 however shows a strong geographical concentration, with more than half of the breeding pigs
116 being reared in eleven regions of Denmark, Germany, Spain, France, the Netherlands and Poland.
117 Pig rearing in the EU also shows considerable variations with respect to the herd size, which may
118 be seen as an indication of industrialization and biosecurity. Although only 1.7% of all pig farms
119 have at least 400 fattening pigs, these units rear 77.9% of all fattening pigs and 48.6% of all
120 sows. On the other hand, small units of less than 10 fattening pigs account for 73.3% of all pig
121 farms, while rearing only 3.8% of all fattening pigs. The proportion of pigs reared in these
122 smallholder farms varies strongly between member states, amounting to 22% of all pigs reared in
123 the 13 newest EU member states, and 63% of pigs reared in Romania (Figure 2). However, the
124 proportion of smallholder pig farms in these new member states is decreasing, as industrialization
125 of the pig rearing sector is actively encouraged (Wellbrock et al., 2010). Further information from
126 FAO shows that the proportion of pigs kept in low biosecurity farms in Belarus, the Russian
127 Federation, Ukraine, and the Republic of Moldova, ranged from 25 to 83% in 2000-2011
128 (Khomenko et al., 2013; Figure 2). Information from other non-EU member states could not be
129 retrieved, although an important contribution of smallholder pig farms is also likely in Balkan
130 countries. As most of these countries are formal or potential candidates for EU membership, it is
131 expected that they are also in the process of speeding up modernisation and intensification of
132 their pig sector.

133 Certified organic pig farming still holds a very minor share in the EU pig market, amounting to
134 0.9 million heads in 2011 (EC, 2013). It is mainly practiced in the old EU member states, with
135 Germany, Denmark and France being the largest producers, although there is also an increasing
136 scope in other countries (Papatsiros et al., 2012). To our knowledge, the risk of introducing *T.*
137 *solium* in such farms is currently unknown, though probably less than in traditional backyard

138 systems, as certified organic farms usually have properly controlled outside access with proper
139 feeding. However, with growing consumer demand for organic pork, uncertified small-scale
140 production units are on the rise.

141 **Discussion**

142 The occurrence of *T. solium* in Europe is known since antiquity, demonstrated by the writings of
143 Aristotle, who compared the appearance of "pork measles" to hailstones (Schantz, 2002). In the
144 nineteenth century, European clinicians unravelled the parasite's lifecycle. Since then, improved
145 pig rearing conditions seem to have eliminated the parasite in most Western European countries.
146 However, little is known about the current true endemicity status of *T. solium* throughout Europe.

147 Three recent and independent reviews indicated that, although autochthonous *T. solium*
148 taeniosis/cysticercosis may be possible in Europe, peer-reviewed literature does not provide
149 sufficient information on the current endemicity status of *T. solium* in Europe. Indeed, only few
150 case reports were available from Eastern European countries. Nevertheless, recent serological
151 studies in Croatia (Meštrović et al., 2012) and Slovenia (Šoba et al., 2014) show that
152 neurocysticercosis does deserve further attention in this region. The available literature, biased
153 towards Western European countries, also showed remarkably high numbers of cases from the
154 Iberian peninsula. Most case reports further did not mention any investigation towards a possible
155 tapeworm carrier, the source of cysticercosis. From an epidemiological and public health point of
156 view, this is however crucial. Even though clinical disease can occur many years after infection,
157 cysticercosis cases are warning signs for the possible presence of a *T. solium* tapeworm carrier.
158 By screening patients and their contacts for taeniosis, clinicians may therefore play an important
159 role in the early detection of such tapeworm carriers. Furthermore, as all tapeworms found could
160 be *T. solium*, proglottids should systematically be examined by molecular methods for species
161 identification.

162 Officially reported data on porcine cysticercosis are highly insufficient. Indeed, not all countries
163 report their findings, and reported cases are typically diagnosed based on morphology, without
164 molecular confirmation. We therefore urge all member states to report their findings on
165 cysticercosis to the concerned European agencies. Cases of so-called "porcine cysticercosis"
166 should be better defined, e.g., differentiating *T. solium*, *T. hydatigena* and *Echinococcus*

167 *granulosus*. To this end, better training of meat inspectors is crucial. The high numbers reported
168 in certain Eastern European countries require further investigation, including molecular
169 confirmation of suspected *T. solium* cysticerci. In Spain, molecular methods have already shown
170 that suspect lesions were in fact *T. hydatigena*, and not *T. solium* (González et al., 2006).

171 Although the ongoing integration of the EU is speeding up industrialization in the pig sector,
172 favourable conditions for local *T. solium* transmission still exist in eastern parts of Europe. The
173 situation in the new EU member states, the candidate Balkan member states, and the Eastern
174 European non-member states therefore deserves special attention. Veterinary public health
175 authorities should remain conscious about the problem, and epidemiological studies are needed to
176 assess the current situation. Evidence is needed to assess the potential risk of importation of
177 unsafe pork from one European country to another.

178 **Conclusion**

179 Further evidence is urgently needed to fill the gaps on the European *T. solium* endemicity map,
180 and it is clear that this should be a shared responsibility of both the medical and veterinary sector.
181 We urge to make human cysticercosis a notifiable disease and to develop a register of human
182 cysticercosis cases. Further efforts are needed to make sleeping data, or "lost science" (Del
183 Brutto, 2012), available, especially from Eastern European countries. Active epidemiological
184 research is needed to generate new information. Recently, several European groups joined forces
185 in a European network on taeniosis/cysticercosis, CYSTINET (COST Action TD1302). We hope
186 that CYSTINET can play an important role in accomplishing these challenging tasks.

187 **Acknowledgments**

188 This work is a collaboration within the framework of CYSTINET, the European network on
189 taeniosis/cysticercosis, COST ACTION TD1302.

190

191 **References**

192 Åhlberg, T., Dorbek-Kolin, E., Tummeleht, L., Johansen, M.V., Lassen, B., 2015. Prevalence
193 study of cysticercosis in Estonian pigs and cattle. Poster presented at the Scandinavian-Baltic
194 Society meeting in Uppsala, April 2015.

195 BIOHAZ/AHAW, 2007. Review of the Community Summary Report on Trends and Sources of
196 Zoonoses, Zoonotic agents and Antimicrobial Resistance in the European Union in 2005 -
197 Scientific Opinion of the Scientific Panel on Biological Hazards (BIOHAZ) and Animal Health
198 and Welfare (AHAW). The EFSA Journal. 600, 1–32.

199 Del Brutto, O.H., 2012. Neurocysticercosis in Western Europe: a re-emerging disease? Acta
200 Neurol. Belg. 112, 335–343.

201 Dorny, P., Praet, N., Deckers, N., Gabriel, S., 2009. Emerging food-borne parasites. Vet.
202 Parasitol. 163, 196–206.

203 Dorny, P., Vallée, I., Alban, L., Boes, J., Boireau, P., Boué, F., et al., 2010. Development of
204 Harmonised Schemes for the Monitoring and Reporting of *Cysticercus* in Animals and
205 Foodstuffs in the European Union. European Food Safety Authority, Parma.

206 EC, 2013. Facts and Figures on Organic Agriculture in the European Union. European
207 Commission, Brussels.

208 EFSA, 2008. The Community Summary Report on Trends and Sources of Zoonoses, Zoonotic
209 Agents, Antimicrobial resistance and Foodborne outbreaks in the European Union in 2006.
210 European Food Safety Authority, Parma.

211 EFSA, 2012. EU summary report on zoonoses, zoonotic agents and food-borne outbreaks 2010.
212 European Food Safety Authority, Parma.

213 Fabiani, S., Bruschi, F., 2013. Neurocysticercosis in Europe: Still a public health concern not
214 only for imported cases. Acta Trop. 128, 18–26.

- 215 FAO/WHO, 2014. Multicriteria-based ranking for risk management of food-borne parasites.
216 Microbiological Risk Assessment Series No. 23. Food and Agriculture Organization of the
217 United Nations/World Health Organization, Rome.
- 218 Gabriël, S., Johansen, M.V., Pozio, E., Smit, G.S., Devleeschauwer, B., Allepuz, A.,
219 Papadopoulos, E., van der Giessen, J., Dorny, P., 2015. Human migration and pig/pork import in
220 the European Union: What are the implications for *Taenia solium* infections? *Vet. Parasitol.* In
221 press.
- 222 González, L.M., Villalobos, N., Montero, E., Morales, J., Sanz, R.A., Muro, A., Harrison, L.J.,
223 Parkhouse, R.M., Gárate, T. Differential molecular identification of *Taeniid* spp. and *Sarcocystis*
224 spp. cysts isolated from infected pigs and cattle. *Vet. Parasitol.* 142, 95–101.
- 225 Khomenko, S., Beltrán-Alcrudo, D., Rozstalnyy, A., Gogin, A., Kolbasov, D., Pinto, J., et al.,
226 2013. African swine fever in the Russian Federation: Risk factors for Europe and beyond.
227 *Empres Watch.* 28, 1–14.
- 228 Kozłowska-Łój, J., 2011. Prevalence of cysticercosis in cattle and pigs in the Lublin province in
229 the years 2005-2008. *Wiad. Parazytol.* 57, 193–194.
- 230 Kozłowska-Łój, J., Łój-Maczulska, A., 2014. Prevalence of cysticercosis in cattle and pigs in the
231 Lublin province in the years 2009-2012. *Ann. Parasitol.* 60, 390–310.
- 232 Marquer, P., Rabade, T., Forti, R., 2014. Pig farming in the European Union: considerable
233 variations from one Member State to another. *Statistics in Focus.* Eurostat, Kirchberg.
- 234 Meštrović, T., Sviben, M., Vilibić-Čavlek, T., Ljubin-Sternak, S., Tabain, I., Mlinarić-Galinović,
235 G., 2012. Seroprevalence of *Taenia solium* infections in Croatian patients presenting with
236 epilepsy. *J. Helminthol.* 86, 259–262.
- 237 Papatsiros, V.G., Tassis, P.D., Christodouloupolos, G., Boutsini, S., Tsirigotakis, G., Tzika, E.D.,
238 2012. Health and production of Greek organic pig farming: Current situation and perspectives. *J.*
239 *Hellenic Vet. Med. Soc.* 63, 37–44.

- 240 Schantz, P.M., 2002. *Taenia solium* cysticercosis: an overview of global distribution and
241 transmission, in: Singh, G., Prabhakar, S. (Eds.), *Taenia solium* Cysticercosis From Basic to
242 Clinical Science. CABI, United Kingdom, pp. 63–73.
- 243 Šoba, B., Beović, B., Lužnik, Z., Skvarč, M., Logar J., 2014. Evidence of human
244 neurocysticercosis in Slovenia. *Parasitology*. 141, 547–553.
- 245 Wellbrock, W., Antunovic, B., Oosting, S.J., Bock, B.B., 2010. Smallholder pig farming in
246 Croatia: Destined to become extinct or worth saving? Proceedings of the 9th European IFSA
247 Symposium, 4-7 July 2010, Vienna, Austria, pp. 1036–1043.
- 248 WHO, 2015. Investing to overcome the global impact of neglected tropical diseases: third WHO
249 report on neglected diseases 2015. World Health Organization, Geneva.
- 250 Zammarchi, L., Strohmeyer, M., Bartalesi, F., Bruno, E., Muñoz, J., Buonfrate, D., Nicoletti, A.,
251 García, H.H., Pozio, E., Bartoloni, A., 2013. Epidemiology and management of cysticercosis and
252 *Taenia solium* taeniasis in Europe, systematic review 1990-2011. *PLoS One*. 8: e69537.

253

254 **Figure legends**

255 Figure 1. World Health Organization definition of European countries and areas at risk of
 256 cysticercosis, 2012 (WHO, 2015)

257 Figure 2. Percentage of pigs kept in smallholder farms (after Khomenko et al., 2013 and Marquer
 258 et al., 2014)

259

260

261

262

263 Table 1. Porcine cysticercosis cases reported to the World Organisation for Animal Health from
 264 2005 onwards (sorted by period)

Country	Region	Period	Number of cases
Slovakia	Banska Bystrica	Jun 2014	1
Slovakia	Banska Bystrica	Nov 2013	1
Romania	Ialomita	Dec 2013	3
Spain	Catalonia	Jan-Jun 2013	5
Romania	Satu Mare	Mar 2011	1
Romania	Satu Mare	Feb 2011	1
Serbia	Whole country	Jul-Dec 2009	65
Bulgaria	Whole country	Jan-Jun 2009	3
Spain	Andalusia	Jan-Jun 2009	7
Spain	Andalusia	Jul-Dec 2008	1
Bulgaria	Whole country	Jan-Jun 2008	12
Spain	Catalonia	Jan-Jun 2008	1
Spain	Madrid	Jan-Jun 2008	47
Bulgaria	Whole country	Jul-Dec 2007	3
Spain	Catalonia	Jul-Dec 2007	233

Slovenia	Maribor	Nov 2007	1
Bulgaria	Whole country	Jan-Jun 2007	30
Bulgaria	Whole country	Jul-Dec 2006	152
Serbia & Montenegro	Whole country	Jul-Dec 2006	4
Spain	Catalonia	Jan-Jun 2006	37
Bulgaria	Whole country	Jan-Jun 2006	316
Slovenia	Maribor	Jan 2006	1
Bulgaria	Whole country	Jul-Dec 2005	205
Bulgaria	Whole country	Jan-Jun 2005	136

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266

***Taenia solium* endemicity**



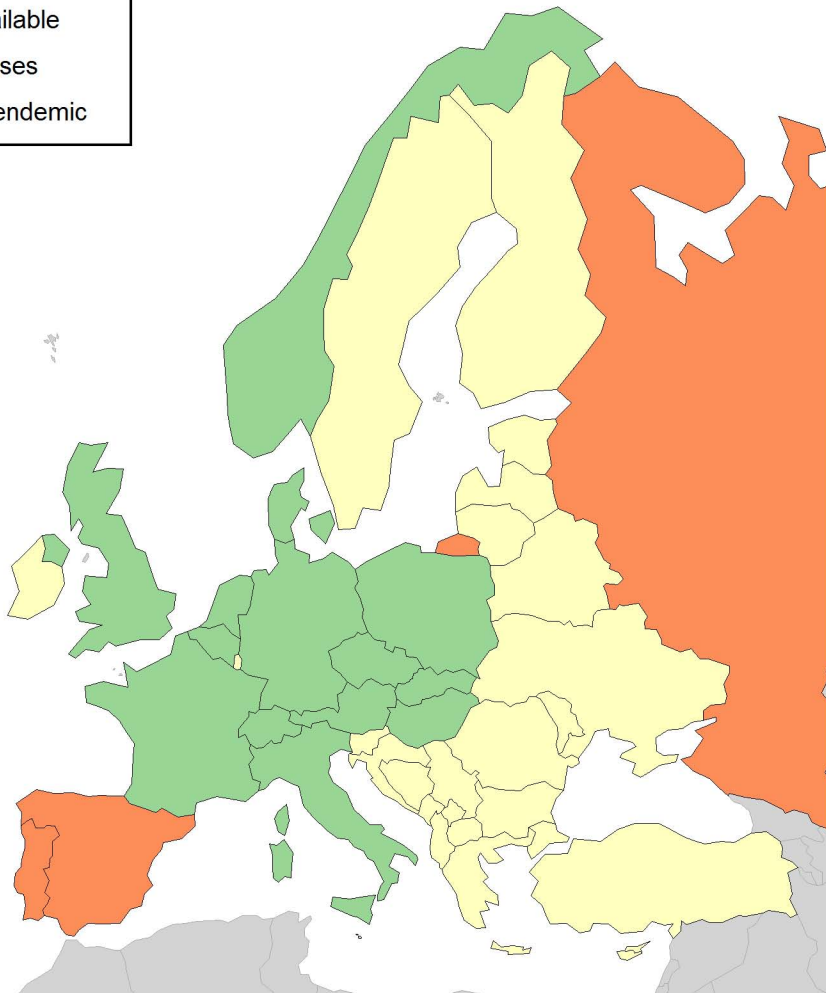
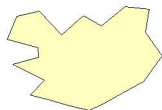
No data available



Imported cases



Suspected endemic



% Smallholder pigs

