SCIENTIFIC OPINION

Statement on the identity of apple snails[1]

EFSA Panel on Plant Health (PLH)[2, 3 4]

European Food Safety Authority (EFSA), Parma, Italy

ABSTRACT

Following a request by the European Commission, EFSA's Panel on Plant Health was asked to deliver a statement to clarify the current scientific knowledge regarding the identity of the apple snails in the context of the evaluation of the pest risk analysis prepared by the Spanish Ministry of Environment and Rural and Marine Affairs (EFSA Panel on Plant Health (PLH), 2012). The Panel concludes on the risk to plant health posed by *Pomacea* species in the '*canaliculata* complex', that out of the around 50 species in the genus of *Pomacea*, four species *P. canaliculata*, *P. insularum*, *P. lineata* and *P. maculata* belong to the '*canaliculata* complex', where *P. insularum* and *P. maculata* are recently considered to be synonyms. Current methods of identification imply high uncertainty if risk reduction options are applied at the *Pomacea* single species level. The Spanish pest risk analysis identifies important plant health risks connected to *Pomacea* species. The available scientific evidence indicates that other *Pomacea* species may pose similar risks to plant health as identified for *P. insularum*.
The Panel clarifies that risk reduction options should not be targeted to single species of the genus *Pomacea* considering: (i) the dynamical situation in the current study on the systematics of the Ampullariidae species and the genus *Pomacea* in particular; (ii) the uncertainties and the possible unexpected evolution of the invasive potential of species of *Pomacea* other than *P. insularum* and P. *canaliculata*; (iii) the poor knowledge on the trophic habits of many species of the genus *Pomacea*, with possible overlaps in the trophic niche (macrophytes); (iv) the high uncertainty on the identification of the different *Pomacea* species.

KEY WORDS

Apple snail, *canaliculata* complex, *Pomacea canaliculata*, *Pomacea insularum*, *Pomacea* spp.

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SUMMARY

Following a request by the European Commission, EFSA's Panel on Plant Health was asked to deliver a statement to clarify the current scientific knowledge regarding the identity of the apple snails in the context of the evaluation of the pest risk analysis prepared by the Spanish Ministry of Environment and Rural and Marine Affairs (EFSA Panel on Plant Health (PLH), 2012).

The Panel concludes on the risk to plant health posed by *Pomacea* species in the '*canaliculata* complex', that out of the around 50 species in the genus of *Pomacea*, four species *P. canaliculata*, *P. insularum*, *P. lineata* and *P. maculata* belong to the '*canaliculata* complex', where *P. insularum* and *P. maculata* are recently considered to be synonyms.

Current methods of identification imply high uncertainty if risk reduction options are applied at the *Pomacea* single species level.

The Spanish pest risk analysis identifies important plant health risks connected to *Pomacea* species. The available scientific evidence indicates that other *Pomacea* species may pose similar risks to plant health as identified for *P. insularum*.

The Panel clarifies that risk reduction options should not be targeted to single species of the genus *Pomacea* considering: (i) the dynamical situation in the current study on the systematics of the Ampullariidae species and the genus *Pomacea* in particular; (ii) the uncertainties and the possible unexpected evolution of the invasive potential of species of *Pomacea* other than *P. insularum* and P. *canaliculata*; (iii) the poor knowledge on the trophic habits of many species of the genus *Pomacea*, with possible overlaps in the trophic niche (macrophytes); (iv) the high uncertainty on the identification of the different *Pomacea* species.

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TERMS OF REFERENCE AS PROVIDED BY THE EUROPEAN COMMISSION

EFSA is requested, pursuant to Article 29(1) of Regulation (EC) No 178/2002, to provide a scientific opinion in connection with a recently published scientific opinion of EFSA in the plant health area evaluating the pest risk analysis on *Pomacea insularum*, the island apple snail, prepared by the Spanish Ministry of Environment and Rural and Marine Affairs (EFSA Journal 2012;10(1):2552). This scientific opinion, which was prepared upon request from the European Commission (Ref. Ares(2011)1070674 - 10/10/2011), was presented by EFSA to the Standing Committee on Plant Health on 27 January 2012. The opinion was well received by the Committee but questions were raised concerning the identity of the organism that could be subject to phytosanitary regulation. Therefore EFSA is requested to provide a clarification on this issue.

In particular, page 32 of the opinion indicates that "If legislation is considered, the Panel suggests that it should target the entire "canaliculata complex", and not only *P. insularum*, as misidentification of species is likely and further import of *P. insularum* and *P. canaliculata* cannot be excluded". However, the opinion does not explain which *Pomacea* species are part of this complex. Do all species in the *Pomacea* genus form this complex, as suggested in page 3 of the Spanish pest risk analysis (PRA)? EFSA's opinion also seems to use *Pomacea* spp. and "canaliculata complex" as synonyms (for example in the abstract). Is the recommendation to regulate all species belonging to the "canaliculata complex" (and not just *P. insularum* and *P. canaliculata*) due to the risk posed by all these species to plant health or is it due to difficulties in differentiating morphologically single species? This whole issue is actually linked to the following part of the Terms of Reference provided by the Commission for this opinion: "EFSA is also requested to assess whether the PRA sufficiently addresses the risk posed by *Pomacea* spp., other than *P. insularum*". The Standing Committee on Plant Health considered that this is not clearly addressed in the opinion.

The clarifications requested above are urgently needed to be able to proceed with the discussions with the Member States on a possible regulation of *Pomacea* snails in the EU. Therefore EFSA is requested to provide its advice within a month.

EVALUATION

1. Introduction

Following a request from the European Commission, in November 2011, EFSA's Panel on Plant Health (hereinafter referred to as the Panel) was requested to provide a scientific opinion on the evaluation of the pest risk analysis on *Pomacea insularum*, the island apple snail, prepared by the Spanish Ministry of Environment and Rural and Marine Affairs (MERMAS, 2011: hereinafter referred to as the Spanish pest risk analysis). The Panel provided its evaluation in a scientific opinion (EFSA Panel on Plant Health (PLH), 2012).

Following a subsequent request by the European Commission received in 2012, in the context of the evaluation of the Spanish pest risk analysis, the Panel provides in this statement further clarifications on the situation regarding the identity of the apple snails.

The Panel provides information on the systematics of *Pomacea* snails; presents a section on the current scientific knowledge on the taxonomy of the snails and then dedicates a section to the uncertainties and predictions of the invasive potential of the snails. Finally, the Panel provides short clarifications on the four specific questions of the request:

- Which *Pomacea* species are part of the '*canaliculata* complex'?
- Do all species in the *Pomacea* genus form this '*canaliculata* complex'? Clarify synonymy or not between *Pomacea* spp and the '*canaliculata* complex' in the opinion.
- Is the recommendation to regulate all species belonging to the '*canaliculata* complex' (and not just *P. insularum* and *Pomacea canaliculata)*
    - due to the risk posed by all these species to plant health?
    - or is it due to difficulties in differentiating morphologically single species?
- Does the Spanish pest risk analysis sufficiently address the risk posed by *Pomacea* spp., other than *P. insularum*?

2. Systematics of the apple snail

The systematics of the apple snails (Ampullariidae) are unclear, and in some cases it is not certain whether these snails represent single species or species complexes. The cladistics of the entire group is also under discussion as genetic techniques based on DNA extraction and sequencing are producing new information that can be analysed with advanced statistical methods and then used to clarify the phylogenetic relationships among the taxa (Hayes et al., 2009). *Pomacea diffusa* is an example of the complexity surrounding the fine systematics of the group. *P. diffusa* was originally described as a subspecies of *Pomacea bridgesii*. Pain (1960) argued that *Pomacea bridgesii bridgesii* was a larger form with a restricted range, with the smaller *Pomacea bridgesii diffusa* being the common form throughout the Amazon Basin (Brazil, Peru, Bolivia). Cowie and Thiengo (2003) suggested that the latter might deserve full species status, and the two taxa have recently been confirmed as distinct species by genetic analyses (Cowie et al., 2006; Hayes et al., 2009).

3. Taxonomy of the apple snail

The taxonomy of Ampullariidae is notoriously confused and correct identification is often extremely difficult (Pain, 1964; Keawjam, 1986; Cazzaniga, 1987). At present, rapid identification is practically only possible by a morphological identification method based on the combination of snail morphological characters and egg mass morphology. However, genetic results based on analysis of gene markers may be required to distinguish species and to solve problems in taxonomic attribution.

For instance, the difficulties in discriminating *P. canaliculata* from similar species, particularly *P. insularum*, have been noted (Cowie and Hayes, 2005; Cowie et al., 2006) and reflect the species intraspecific morphological variability (Estebenet and Cazzaniga, 1992; Martín and Estebenet, 2002; Estebenet and Martín, 2003). Considerable intraspecific variations are known also for *P. insularum* and well supported by analysis of the phylogenetic structure of the species (Rawlings et al., 2007). The picture is even more complex because populations of *P. canaliculata* are genetically distinct from those of *P. insularum*, as shown from mtDNA sequences, although these species have similar shell morphologies (Rawlings et al., 2007).

Difficulty in taxonomic identification is largely a consequence of the overall conservative external morphology of the group combined with phenotypic plasticity of *Pomacea* species. Shell morphology is often influenced by environmental conditions, geographic barriers, age of the organisms, and other factors affecting adaptation and selection (Inaba, 1961; Burch, 1960, 1967; Diupotex-Chong et al., 2004). Few rigorous morphometric studies have been carried out on the family (Gutiérrez et al., 1994; Simone, 2004). The presently known degree of variability and overlap in shell morphology makes discrimination of the species based on shell shape unreliable (Rawlings et al., 2007).

4. Invasiveness of the apple snail

4.1. Uncertainties in invasive potential

A sudden interest in South American freshwater snails belonging to the genus *Pomacea* commenced in the mid 1980's after *Pomacea* snails had been deliberately introduced into Southeast Asia. Instead of becoming a food resource for the urban poor, *Pomacea* snails became a serious pest of rice (Naylor, 1996) and a threat to natural aquatic ecosystems (Carlsson et al., 2004). At this time it was presumed that a single species, *P. canaliculata*, had been introduced and was spreading through the majority of Southeast Asia (Hayes et al., 2008). Almost three decades later, the development of phylogenetic analysis has allowed researchers to show that at least four *Pomacea* species (*P. canaliculata, P. diffusa*, *P. insularum* and *Pomacea scalaris*) have been introduced from South America into South East Asia (Hayes et al., 2008). The earlier lack of information at the species level has resulted in an extensive documentation of the detrimental impact from the so called *P. canaliculata* in Southeast Asia but it is not known how, and if, the impacts on rice and aquatic ecosystems differ between the four different *Pomacea* species present.

According to the scientific literature (Adalla and Morallo-Rejesus, 1989; Halwart, 1994; Naylor 1996; Wada, 1997; Cowie, 1998; Howells, 2001; Rawlings et al., 2007), the invasiveness of many species of the genus *Pomacea* is well documented. The genus *Pomacea*, which is native to South and Central America, parts of the Caribbean, and the Southeast US, has become widely established in many areas within Southeast Asia, Sri Lanka, Guam, Hawaii, Papua New Guinea, the Dominican Republic, parts of the mainland US, possibly Australia (Rawlings et al., 2007), and recently Spain.

However, the poor knowledge of the biology and ecology of most of the *Pomacea* species does not allow grading of the invasive potential at species level. The understanding of the invasive potential is also limited by possible change in the invasiveness after establishment. Since their initial appearance in the 1950s, the introductions of non-native apple snails largely occurred unimpeded and without much apparent concern in the US (Rawlings et al., 2007). This changed dramatically in the 1990s, with the appearance and rapid spread of channelled apple snails, thought to be *P. canaliculata*, in rice-growing areas of Texas. This is in agreement with a common pattern in invasiveness of invasive species that can maintain limited distributions, sometimes for decades, before becoming invasive (Cox, 2004).

4.2. Predicting the impact

The vast majority of *Pomacea* species are regarded to be primarily plant eaters (macrophytes), which suggests that they all have a similar pest potential even though the magnitude of herbivory is likely to vary between different species (Cowie et al., 2009).

Channeled type apple snails (genus *Pomacea*) are important invaders and agricultural pests of rice and taro (Burlakova et al., 2009) in Thailand, Vietnam, parts of Malaysia and Indonesia, China, Taiwan, Japan, Dominican Republic, Hawaii, and in the Philippines (Cowie, 2002) and are responsible for large economic losses (Ranamukhaarachchi and Wickramasinghe, 2006).

The correct attribution of the reported damages to a given species is often questionable. Some of the ecological and agricultural impacts in Asia associated with *P. canaliculata* are almost certainly attributable to *P. insularum*. This latter species is also widespread in the region (Keawjam and Upatham, 1990; Cowie et al., 2006; Hayes et al., 2009) but has not been explicitly acknowledged as a serious pest because of the confusion in identification of these two species, with most of the literature referring to *P. canaliculata*.

It is also important to consider that the intensity of the threat posed to plant health and to the environment is often unpredictable. The case of *P. diffusa* is emblematic. *P. diffusa* has generally been assumed to pose little threat in the U.S. and it is the only apple snail for which interstate transport is permitted. This lack of concern may be unwarranted (Rawlings et al., 2007). The U.S. Department of Agriculture considered it (as *P. bridgesii*) to be innocuous (Gaston, 2006), presumably based on a study that concluded that it feeds primarily on aufwuchs, not macrophytes (Howells, 2002). However, the potential effects of *P. diffusa* in natural habitats are unknown. There are possible direct effects on both aquatic vegetation and native snails and competition for food with native scavengers such as crayfish, shrimp, and fish (Rawlings et al., 2007).

5. The specific questions of the request

5.1. Which *Pomacea* species are part of the '*canaliculata* complex'?

The '*canaliculata* complex' became one way to group some *Pomacea* species that exhibited several common features as well as an invasive behaviour. The grouping, however, is based mainly on morphological similarities of the species it includes and has triggered significant debate. At present a combination of morphological characters and egg mass morphology is the best strategy for a rapid identification. However, further genetic studies based on the analysis of genetic markers may be required to distinguish species and to solve remaining problems in taxonomic attribution.

Currently, the following species are considered to belong to the '*canaliculata* complex': *P. canaliculata, P. insularum*, *Pomacea lineata* and *Pomacea maculata* (Cowie et al., 2006). However, *P. insularum* and *P. maculata* are now considered to be synonyms (Cowie et al. 2006; Cowie, publication in preparation). Several species have been considered by different authors to be synonyms of either *P. canaliculata* or other species that were as well synonymised with *P. canaliculata*: *Pomacea australis*, *Pomacea chaquensis*, *Pomacea dorbignyana*, *Pomacea haustrum*, *Pomacea immersa,* and *Pomacea vermiformis* (Cowie and Thiengo, 2003).

It has to be emphasised, that the '*canaliculata* complex' is not representing a taxon – i.e., a clear differentiation of this complex from other *Pomacea* species is not based on consistent, reproducible taxonomic criteria.

5.2. Do all species in the *Pomacea* genus form this complex? Clarify synonymy or not between *Pomacea* spp. and the '*canaliculata* complex' in the opinion

No, the genus *Pomacea* currently includes around 50 species; only a few of them belong to the '*canaliculata* complex'. In the scientific opinion of the Panel (EFSA panel on Plant Health (PLH), 2012), *Pomacea* spp. was synonymised with the '*canaliculata* complex'. The abbreviation "spp." means "*Species pluralis*" and is the Latin abbreviation for multiple species, so it does not necessarily include all *Pomacea* species, but only those that are subject of discussion – in this case those that are deemed to be in the '*canaliculata* complex' (see question above).

5.3. Is the recommendation to regulate all species belonging to the '*canaliculata* complex' (and not just *P. insularum* and *P. canaliculata*)

- due to the risk posed by all these species to plant health?
- or is it due to difficulties in differentiating morphologically single species?

The plant health risk posed by the '*canaliculata* complex', as assessed by the Panel, is based on the available evidence from the scientific literature. Most *Pomacea* species are regarded as primarily plant eaters, which suggests, that they all have a similar pest potential even though the magnitude of herbivory may vary between different species (Cowie et al., 2009). As outlined above, differentiation of *Pomacea* species on a morphological basis is difficult as within species variation is high and morphological similarities are shared between many different species. Risk assessment at the species level will therefore remain difficult until the systematics, the taxonomy, and the ecology of the different *Pomacea* species have been resolved further. It needs to be emphasized here that the Panel does not make recommendations regarding regulatory decisions.

5.4. Does the Spanish pest risk analysis sufficiently address the risk posed by *Pomacea* spp. other than *P. insularum*?

The Spanish pest risk analysis focuses on both *P. insularum* and *P. canaliculata*, since these are the most invasive species in the *Pomacea* genus recognised so far (Hayes et al., 2008).

The Spanish pest risk analysis states: "Most snail problems in Asian countries are caused by species in the '*canaliculata*' group, the most often cited species being *P. canaliculata* (Lamarck 1822), *P. insularum* (d'Orbigny 1835), and *P. lineata* (Spix in Wagner 1827)". The Spanish pest risk analysis does not discuss *P. lineata*, though. However, as already outlined above, at least four *Pomacea* species (*P. canaliculata, P. diffusa, P. insularum* and *P. scalaris*) have been introduced from South America into Southeast Asia (Hayes et al., 2008). In the vast majority of studies that have quantified the detrimental effects from *Pomacea* snails on aquatic crops/plants in Southeast Asia, it has been presumed that the experimental organism was *P. canaliculata.* Thus, reliable information on differences in herbivory among the four different *Pomacea* species present in Southeast Asia is lacking. Therefore, there is significant uncertainty regarding both the invasiveness of and impacts from other *Pomacea* species than *P. insularum* and *P. canaliculata*. These uncertainties could have been developed further in the Spanish pest risk analysis.

CONCLUSIONS

Following a request by the European Commission, EFSA's Panel on Plant Health was asked to deliver a statement to clarify the current scientific knowledge regarding the identity of the apple snails in the context of the evaluation of the pest risk analysis prepared by the Spanish Ministry of Environment and Rural and Marine Affairs (EFSA Panel on Plant Health (PLH), 2012).

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DOCUMENTATION PROVIDED TO EFSA

1. Letter from the European Commission (Ref. Ares (2012)150532) dated 09 February 2012.

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