

Scophthalmus Rafinesque, 1810: The valid generic name for the turbot, *S. maximus* (Linnaeus, 1758) [Pleuronectiformes: Scophthalmidae]

by

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ABSTRACT. - In the past 50 years, the turbot is referred to either as *Scophthalmus maximus* (Linnaeus, 1758) or *Psetta maxima* (Linnaeus, 1758) in the literature. Norman (1931) had argued that the valid name for the turbot was *Scophthalmus maximus*. However, his recommendation was never universally accepted, and today the confusing situation exists where two generic names are still being used for this species. We address this issue by analysing findings from recently published works on the anatomy, molecular and morphological phylogenetic systematics, and ecology of scophthalmid fishes. The preponderance of evidence supports the strong recommendation to use *Scophthalmus* as the valid generic name for the turbot. Acceptance of this generic name conveys the best information available concerning the systematic relationships of this species, and also serves to simplify the nomenclature of scophthalmid flatfishes in publications on systematics, fisheries and aquaculture, fishery statistics, ichthyofaunal and field guides for the general public, and in various legal and conservation-related documents. This paper reinforces the conclusions of Chanet (2003) with more arguments.

RÉSUMÉ. - *Scophthalmus* Rafinesque, 1810: le nom de genre valide du turbot, *S. maximus* (Linnaeus, 1758) (Pleuronectiformes: Scophthalmidae).

Depuis 50 ans, le turbot est dénommé dans la littérature soit *Scophthalmus maximus* (Linnaeus, 1758), soit *Psetta maxima* (Linnaeus, 1758). Norman (1931) avait montré que le nom valide pour le turbot était *Scophthalmus maximus*. Cependant, sa recommandation ne fut jamais universellement appliquée, et aujourd'hui la situation reste confuse avec deux noms génériques en usage pour cette espèce. Nous résolvons ici ce problème par l'analyse de travaux récents (morphologiques, anatomiques, moléculaires et écologiques) portant sur la systématique des Scophthalmidae. L'ensemble des données disponibles amène à considérer que *Scophthalmus* est le nom de genre valide pour le turbot. Accepter ce nom de genre revient non seulement à véhiculer la meilleure information en terme de relations de parenté entre espèces, mais aussi à simplifier la nomenclature des Scophthalmidae dans les publications traitant de systématique, d'halieutique, d'aquaculture, d'écologie, dans les guides pour le grand public et les documents législatifs. Le présent travail renforce les conclusions de Chanet (2003) en apportant des arguments supplémentaires.

Key Words. - Scophthalmidae - *Scophthalmus* - *Psetta* - Turbot - Systematics - Nomenclature.

The turbot, *Scophthalmus maximus* (Linnaeus, 1758), is an important commercial and highly esteemed species dating back to Antiquity (Chanet, 2003). Consequently, we might imagine that the taxonomy and nomenclature of this species are both clear and stable. Unfortunately, this is not the case as there has been a long history of confusion and controversy regarding the valid genus name for the turbot, the main topic of this paper, and also regarding the existence of one or two species. In the past 50 years and up to the present days of ichthyological popular and scientific literature, the scientific species name used for the turbot is either *Scophthalmus maximus* (Linnaeus, 1758) or *Psetta maxima* (Linnaeus, 1758), more or less indistinctly (the original combination

is *Pleuronectes maximus* Linnaeus, 1758). The confusion/controversy regarding the valid generic name for this species persists to this day although Norman (1931) thoroughly discussed the nomenclature of *Scophthalmus* Rafinesque, 1810 and *Psetta* Swainson, 1839, and concluded that *Scophthalmus* is the valid generic name for the turbot.

The choice of *Psetta* in major check-lists, ichthyofaunas and FAO (e.g., Nielsen 1973, 1986; FAO, 2009), as well as in recent national check-lists or red lists (e.g., Plikss, 2002; Evseenko, 2003; Bicenoglou *et al.*, 2005; Fricke, 2007; Fricke *et al.*, 2007; Plejic, 2007; Dhora, 2010) resulted in the selection of *Psetta maxima* as the current accepted name in the two major global fish databases (Eschmeyer and Fricke,

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2010; Froese and Pauly, 2010), and thus disseminated to other global catalogues (Bailly, 2009; Bisby *et al.*, 2009, in press), although Bailly (2001) selected *Scophthalmus* for the European Register of Marine Species (ERMS), and by other authors (Ojaveer *et al.*, 2003; Riede, 2004; Azevedo *et al.*, 2007). All these works did not incur new taxonomic investigations, although the latter give information on genetics. Nelson (2006) almost alone did retain explicitly the conclusion of Chanet (2003) in the 4th edition of *Fishes of the World*.

The findings presented in a recent (and the only) phylogenetic analysis of all the species of the scophthalmid flatfishes (Chanet, 2003) do not provide resolution to the question of generic placement of the turbot. After a strict cladistic analysis on morphological and anatomical features, Chanet (2003) found that *Scophthalmus maximus* belonged to a clade that also included *S. rhombus* (Linnaeus, 1758) and *S. aquosus* (Mitchill, 1815) with the two latter species being more closely related than with *S. maximus*. *S. rhombus* and *S. aquosus* differ from the turbot in having: i) deeply branched anteriormost dorsal-fin rays, ii) rudimentary epural 2, iii) convex shape of the cranium in orbital region, iv) a patch of vomerine teeth. Although these synapomorphies undoubtedly support the proposed phylogeny, Chanet concluded they are not sufficient to support recognition of different generic names for the two clades. Instead, he recommended that only one genus name be used for these three species. Recognizing the monophyly of this 3-species clade within the Scophthalmidae emphasises the large amount of shared characters common to these species, whereas, recognizing two genera among this 3-species clade would emphasize the monophyly of the *rhombus-aquosus* clade but would de-emphasise the close relationship of the three species indicated by the characters they share in common. However, based on the topology of the cladogram, Chanet did not conclude unequivocally whether *Scophthalmus* or *Psetta* is the appropriate generic name for the turbot.

Today, we still have the situation where two generic names are in use to convey information regarding a single species. From a nomenclatural perspective and also from the practical standpoint of information storage and retrieval regarding knowledge about this species, continued use of two generic names for the turbot is confusing, inefficient and unacceptable. Furthermore, it may also diminish possibilities for future researchers unaware of this nomenclatural confusion to make the most meaningful choices when constructing comparative studies among the scophthalmid flatfishes.

To reconcile this situation, we provide several lines of evidence based on morphological information from Chanet's phylogenetic study (2003), other morphological characters and genetic information not used in his cladistic analysis, as well as information on the biology, life history and ecologies of the turbot and closely related species to effectively argue

for accepting *Scophthalmus* as the valid genus name for the turbot. As the two genus names are still in use in the recent literature, we bring here more arguments to follow the conclusions of Chanet (2003).

MATERIAL AND METHODS

Three Biodiversity Information Systems were searched early February 2010 to get updated information, references and number of uses of the two names in the literature: Catalog of Fishes (Eschmeyer, 2010); FishBase (Froese and Pauly, 2010); Biodiversity Heritage Library (2010). The two formers extracted information mostly from references after 1950, whereas the latter handles publications before 1925.

The Catalog of Fishes can be checked for information on types and nomenclatural issues.

RESULTS

In FishBase, on 135 systematic citations of the species (excluding the fish collection databases), 39 use *Scophthalmus maximus* from 1957 to 2007 and 84 use *Psetta maxima* 1964 to 2010. The frequency of use does not show differences along the years. The remaining are mentions of misidentifications and of the original name, *Pleuronectes maximus* Linnaeus, 1758.

None of the two names could be object of a petition to the International Commission of Zoological Nomenclature on the basis of usage.

In the Biodiversity Heritage Library, in FishBase, on 93 citations of the, 38 use *Scophthalmus maximus* and 55 use *Psetta maxima* (or *P. maximus*).

The use of one or the other name does not seem to be linked to particular type of publications.

DISCUSSION

Scophthalmus maximus and *S. maeoticus*

Presently, depending upon authors, three or four nominal species of scophthalmids are assigned to either *Scophthalmus* Rafinesque, 1810 or *Psetta* Swainson, 1839: the turbot, *Scophthalmus maximus* (L., 1758) or *Psetta maxima* (L., 1758); the brill, *S. rhombus* (L., 1758), the type species of *Scophthalmus* designated by Jordan (1917: 82); the Black Sea turbot, *S. maeoticus* (Pallas, 1814) or *P. maeotica* (Pallas, 1814), often considered a synonym of the previous species; and the windowpane, *S. aquosus* (Mitchill, 1815). Norman (1931: 513) assigned all four of these nominal species to *Scophthalmus*.

From Norman's studies (1931, 1934) until Chanet (2003), there have been no detailed systematic works (i.e., based on detailed study of specimens) that evaluated the status of the nominal genera, *Scophthalmus* and *Psetta*. Some synthetic works, such as regional ichthyofaunas (e.g., Nielsen, 1986; Bilecenoglu *et al.*, 2002), report diagnostic characters – such as the presence/absence of bony tubercles – purported to distinguish the two genera. But how informative of genetic distinctness is the presence/absence of bony tubercles in turbot? The distinction between the two nominal turbot species (*S. maximus* and *S. maeoticus*) is based solely on the presence and size of bony tubercles (Tortonese, 1971; Chanet, 2003). These tubercles are transformed elasmoid scales (Zylberberg *et al.*, 2003). In *S. maximus*, these structures are present only on the eyed-side of the body and are smaller than the diameter of the eye, while, in *S. maeoticus*, they occur on both sides of the body and are larger than the eye diameter (Tortonese, 1971). Chanet (2003) reviewed both literature and specimens, and found that individuals with large tubercles on both sides of the body are not rare, and are not limited to the Black Sea. For instance, several turbot were collected in the Baltic Sea that had Black Sea-like tubercles. Based on morphological data, Chanet (2003) tentatively concluded that *S. maximus* and *S. maeoticus* are conspecific, with *S. maximus* being the senior available name for this species. He further concluded that this problem should be addressed using molecular techniques (mitochondrial or microsatellite DNA). Suzuki *et al.* (2004) published an analysis of mitochondrial DNA with 66 turbot specimens sampled in the Atlantic Ocean, western Mediterranean Sea, Aegean Sea, Sea of Marmara, Black Sea off Turkey and Romania, and Azov Sea. Nielsen *et al.* (2004) studied eight microsatellite loci in 706 turbot specimens collected from the Bay of Biscay to the Baltic Sea. In both works the genetic divergence within these populations was found to be low and was considered by these authors to represent only intraspecific differences. Most importantly, genetic differences were not related to the presence or size of tubercles because specimens =with large tubercles on both sides of their bodies occurring in the same geographic area were not closely related (Suzuki *et al.*, 2004). Therefore, findings from morphological (Chanet, 2003) and genetic studies (Suzuki *et al.*, 2004; Nielsen *et al.*, 2004) are in agreement that the variation in body tubercles is not a suitable feature to define natural groups within turbot and support that only a single species of turbot is present among specimens with or without tubercles of varying sizes. Azevedo *et al.* (2008) conducted a phylogenetic analysis of the order Pleuronectiformes based on sequences of 12S and 16S mitochondrial genes where four scophthalmid species (*Lepidorhombus wiffiagonis*, *S. maximus*, *S. aquosus* and *S. rhombus*) were included. These authors confirm the monophylies of the family Scophthalmidae and the genus *Scophthalmus*. Further, in the consensus maximum-parsimony tree of Azevedo *et al.* (2008: 288, fig. 2)

and in the consensus tree produced by a Bayesian analysis of Azevedo *et al.* (2008: 288, fig. 3) *S. maximus* is more closely related to *S. aquosus* than to *S. rhombus*, contradicting the results of Chanet (2003), where *S. rhombus* and *S. aquosus* were closely related. But, in the consensus tree produced by a maximum likelihood analysis of Azevedo *et al.* (2008: 289, fig. 4) *S. maximus* and *S. rhombus* appear as sister-groups. However, these discrepancies on terminal branches between the analyses do not modify the problem of generic name of the turbot and are probably linked to sampling bias (Azevedo *et al.*, 2008, only studied half of the species of the family) and to the doubtful interest of the studied genes for interspecific relationships.

Nomenclatural history

As for the many European teleostean species, scientific nomenclature for the turbot begins with Linnaeus (1758: 271) when he named this species *Pleuronectes maximus*. For Linnaeus (1758, 1766), *Pleuronectes* is a genus containing all of the then known species of flatfishes, which includes 16 species described in 1758 plus two more in 1766. Rafinesque (1810: 14) created the genus *Scophthalmus*, to which he assigned both *Pl. maximus* and *Pl. rhombus* (Linnaeus, 1758). Later, Cuvier (1817: 222) assigned both species to *Rhombus*, but, as Norman (1931: 511) noted, this assignment was unnecessary because *Scophthalmus* had priority over *Rhombus*. Subsequent to Cuvier's studies, Swainson (1839: 302) created the genus *Psetta*, with the type species (by monotypy) being the turbot, *Psetta maximus* (species name later corrected to *Psetta maxima* by Bonaparte (1846: 49) to agree in gender). Unfortunately, Swainson did not mention the brill, *Scophthalmus rhombus* (Linnaeus, 1758) in his study. Therefore, two generic names have been available for the turbot since 1839, *Scophthalmus* and *Psetta*. Norman's studies (1931, 1934) placed *Psetta* in the synonymy of *Scophthalmus*. However, as pointed out by Norman (1931), *Psetta* is an available and valid genus name for *Pleuronectes maximus* because although *Psetta* was first published by Klein in 1775 for an Acanthuridae, the work did not conform to the principle of binominal nomenclature and the name is not available from that author (see Eschmeyer and Fricke, 2010 for further details). Norman's conclusion to recognize only one genus for the turbot has not been universally accepted by subsequent researchers.

Cotte (1944) analyzes that "*psetta*" was a fish name used by Greek (Aristotle,...) and Roman (Plinius, Oppien, Athenus,...) authors during Antiquity. He made an attempt to link the name used at that time and the species as we circumscribe them today. He gave strong evidences to link "*rhombus*" to the brill, but he was less successful with "*psetta*" that he also links to the brill. Our guess is that the name was used for both species. Nevertheless, these pre-Linnean works have no influence on the nomenclature according to

the International Code of Zoological Nomenclature.

In addition to close relationship as indicated in the cladogram presented in Chanet (2003) and in Azevedo *et al.* (2008), the three species also show a high similarity with respect to their morphology, biology and ecology. They differ from other scophthalmid species by being large, epibenthic and stenohaline species (Able and Fahay, 1988; Nielsen, 1986; Morse and Able, 1995; Quéro and Vayne, 1997; Person-Le Ruyet, 2000; Bond and Lyczowski-Schultz, 2006; Chanet and Branellec, 2008).

CONCLUSION

Systematics deals with communication of all information on living organisms on Earth. This field of study aims at discovering, synthesising and organising all of what we may know about individuals we observe (Systematics Agenda 2000, 1994), so that we are able to speak about their morphological features, biological and ecological characteristics in a synthetic and simplified manner (hence the grouping of individuals in species, species in genera, genera in families, etc.). For such a purpose, and as its fundamental framework, systematics uses the result of taxonomy that delivers both a phylogenetic/classification backbone and scientific names. These scientific names are used as the gateways for indexing and retrieving all information. Scientific names are the access points to communicate, through oral discussions, printed documents, and more recently, electronic medias, especially database- and web-based Biodiversity Information Systems, about species and other taxa. Scientific nomenclature should convey the best available information concerning the evolutionary relationships of the taxa under discussion. At the same time, keeping the nomenclature as simple or as uncomplicated as possible should also be a goal for every taxonomist.

Situations, such as the present one, where two generic names are available for a species, are unacceptable. Duplication of generic assignment of any species is counterproductive to the goals of nomenclature and creates an inefficient and confusing situation concerning information storage and retrieval regarding that species. Determining whether or not *Scophthalmus* or *Psetta* is the valid genus name for the turbot, requires the analysis of a variety of morphological and biological data, as well as conformation to the rules for scientific nomenclature. The preponderance of evidence evaluated indicates close relationship among three scophthalmid species, *S. aquosus*, *S. rhombus* and *S. maximus* (with *S. maeoticus* being a junior synonym of the later). Acceptance of *Scophthalmus* as the valid genus name for the turbot, as assessed by Norman (1931), thereby relegating *Psetta* as a junior synonym of *Scophthalmus*, conveys the best information regarding the relationship of this species to the other

Scophthalmidae, and synthesizes in the best way the shared morphological, anatomical, biological and ecological traits of the three species compared to the other species in the family. Furthermore, in adopting *Scophthalmus* as the valid genus name for this taxon eliminates any further confusion resulting from the use of two generic names for this species, and to that end will help stabilize and simplify nomenclature within the Scophthalmidae. Recognizing the turbot as a member of *Scophthalmus* best reflects our information regarding the relationships of this species among the Scophthalmidae, provides a measured step towards stabilizing the nomenclature of this species, and improves the practical aspects of information storage and retrieval for this species.

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