Comment on *Acarus putrescentiae* Schrank, 1781 (currently *Tyrophagus putrescentiae*; Acariformes, ACARIDAE): proposed conservation of usage by designation of a replacement neotype
(Case 3501; see BZN **67**: 24–27; **71**: 99–102)

Pavel B. Klimov

University of Michigan, Museum of Zoology, Ann Arbor, MI, U.S.A.
(e-mail: pklimov@umich.edu)

Barry M. OConnor

University of Michigan, Museum of Zoology, Ann Arbor, MI, U.S.A.
(e-mail: bmoc@umich.edu)

This is a response to Fan & Zhang's (BZN **71**: 99–102) comment on Case 3501, which involves a conflict between two fundamental principles of zoological nomenclature as embodied in the Code: the Principle of Priority and the need for stability in the use of names. The Introduction of the current Code states, '. . .the Code recognizes that the rigid application of the Principle of Priority may, in certain cases, upset a long-accepted name in its accustomed meaning through the validation of a little-known, or even long-forgotten name. Therefore the rules must enable the Principle of Priority to be set aside on occasions when its application would be destructive of stability or universality, or would cause confusion'.

Here we provide a brief overview of the case, a discussion of the alternative solution (Fan & Zhang, BZN 71: 99–102), evaluate the reaction of the scientific community, and then give a detailed response to Fan & Zhang's criticism. Throughout the text, we use the following conventions: *Tyrophagus putrescentiae* (common species, = *communis* sensu Fan & Zhang, 2007b) and *Tyrophagus fanetzhangorum* (rare species, = *putrescentiae* sensu Fan & Zhang, 2007b). These two species are genetically distinct and can be easily separated by morphology (Fan & Zhang, 2007; Klimov & OConnor, 2009) and DNA sequences (Beroiz et al., 2014; Klimov & OConnor, 2009).

Case overview

During the course of a revision of Australasian species of the mite genus *Tyrophagus* Oudemans, 1924, Fan & Zhang (2007b) discovered that two distinct morphospecies had been confused under the name, *Tyrophagus putrescentiae* (Schrank, 1781), an extremely common, cosmopolitan mite of considerable medical and agricultural importance. In their material examined from the region and elsewhere, one of the forms was considered 'common' and the other 'rare'. They determined that the neotype designated for this species by Robertson (1959) and validated by Opinion 1298 (BZN **42**: 124–126 (June 1985)) does not correspond to the commoner species but to the rarer species. Strictly applying the Principle of Priority, Fan & Zhang (2007b) applied the name '*Tyrophagus putrescentiae*' to the rare species. Those authors did not follow the provision of Article 75.6, which states, 'When an author discovers that the existing name-bearing type of a nominal species-group taxon is not in taxonomic accord with the prevailing usage of names and stability or universality

is threatened thereby, he or she should maintain prevailing usage [Art. 82] and request the Commission to set aside under its plenary power [Art. 81] the existing name-bearing type and designate a neotype.' Note that we did not suggest that Robertson's original neotype designation is invalid under Article 75.7 (new in the 4th edition of the Code) because it does appear to meet all the qualifying conditions of the current edition for such designations.

The action of Fan & Zhang (2007b) created nomenclatorial instability because it required that the name of the common species be changed. Based on our study of taxa with existing types (Klimov & OConnor, 2009), there are several available names for the common species. Among these, *T. americanus*, *T. breviceps*, and *T. cocciphilus*, are the oldest names proposed in the same post-1900 publication (Banks, 1906). There are three species described before 1899 and included in the synonymy of *T. putrescentiae* by Robertson (1959) for which types could not be located (*Coelognathus morsitans* Hessling, 1852, *Tyroglyphus lintneri* Osborn, 1893 and *Tyroglyphus ananas* Tryon, 1898). Because these latter names meet the criteria of Article 23.9, they would not be given precedence over Banks' (1906) names. Because the common species has a long taxonomic history, types of these or additional possibly synonymous taxa may be discovered in the future. This poses a great nomenclatorial challenge – choosing the oldest available synonym for the common species in a way that prevents further changes of the name due to the possibility of discovery of additional historical types.

To maintain the stability of nomenclature, we petitioned the Commission, under Article 75.6, to set aside the existing neotype for *Acarus putrescentiae* Schrank, 1781, and designate a replacement neotype that is consistent with the prevailing usage of the name. Approval of this petition will maintain nomenclatorial stability because there would be no need to change names and will provide a reasonable, although inherently probabilistic, legacy for taxonomic and faunistic works published before 2007. Thus, we propose a conservative approach that does not depend on the outcome of future work and which provides both stability and legacy.

Fan & Zhang's solution

In their comments to our Petition, Fan & Zhang (BZN **71**:102) proposed another solution: 'Nomenclaturally, the proposers of case 3501 can easily solve the taxonomic problem by synonymizing *T. communis* with a senior name'. This, unfortunately, would not solve the central problem of our petition because the nomenclatorial instability for the common species is linked to the uncertainties associated with the historical types / descriptions (see above). Treatment of *T. communis* (a junior synonym) is a minor issue here.

If Fan & Zhang's solution were adopted, then the following situation would arise: (i) the common species (*T. putrescentiae*, as understood by the majority of authors) would have no accepted name pending a large-scale taxonomic revision of historical types of taxa described between 1900 and 1906; but (ii) many researchers and public databases (e.g. GenBank) would be prompted to change the name of the common species to *T. communis* (which is an invalid name); and (iii) after a comprehensive study of historical types and descriptions, the common species would change its name again.

Another disruption associated with Fan & Zhang's solution is the need to change, possibly multiple times, acronyms for important immunogenic proteins. There are

more than 20 groups of allergens that have a specific nomenclature proposed by the International Union of Immunological Societies (IUIS) Subcommittee of Allergen Nomenclature and Standardization (King et al., 1994). For example, Tyr p 2 and Tyr p 10 are the designations for group 2 and 10 allergens of *Tyrophagus putrescentiae*, respectively. These acronyms are so widespread in immunological literature and bioinformatics databases ('prevailing usage' of the name is most often seen in this context) that changing the species name and, concurrently, the allergen abbreviations will be met with a great reluctance from researchers in the fields of medicine, immunology, and molecular biology.

Reaction of the scientific community

Our petition was published five years ago. Subsequently, it has been possible to evaluate the response of the scientific community to our proposal, i.e. to apply Article 82 and conserve prevailing usage. A search for '*Tyrophagus putrescentiae*' yielded 1,870 results and only 4 results for '*Tyrophagus communis*' (Google Scholar, Dec. 24, 2014, phrase quoted, records published since 2009 filtered). For the four results mentioning *T. communis*, only one record used this name as valid – a Ph.D. thesis written entirely in Chinese. Another search for '*Tyrophagus communis*' in the Zoological Record database retrieved a single paper using *T. communis* as a valid name (Cotter et al., 2011). There were no *T. communis* records in the GenBank taxonomy or sequence databases, but for *T. putrescentiae* there were 751 DNA and 1,234 EST sequences (all can be unambiguously attributed to this species).

It is very unlikely that a substantial number of the 1,870 records citing *T. putrescentiae* may refer to Fan & Zhang's concept (i.e. the rare species), because it would be accompanied by an explicit citation. Google Scholar gives only 22 citations of Fan & Zhang's monograph since 2009. To illustrate our point further, we give a list of 16 papers and 1 taxonomic monograph published after 2009 that are in favor of preserving the name of the common species (Beroiz et al., 2014; Eaton & Kells, 2009; Freitag & Kells, 2013; Frost et al., 2010; Guanilo et al., 2012; Hubert et al., 2009, 2012a, 2012b, 2013; Kucerova & Stejskal, 2009; Murillo et al., 2013; Palyvos & Emmanouel, 2011; Que et al., 2014; Solarz, 2012; Stara et al., 2014; Stara et al., 2011; Torre Santana & Rodríguez Castro, 2010). These articles either explicitly cited the taxonomic problem, or deposited sequences matching *Tyrophagus putrescentiae*, or there was secondary evidence (e.g. Freitag cited in a Ph.D. thesis but not in the related paper; Hubert and his group based their work on a culture with known identity).

The evidence given above indicates that the scientific community consistently followed our citation of Article 82 to maintain the prevailing usage of *Tyrophagus putrescentiae* and not to change it to *T. communis* (or any other name).

Fan & Zhang's criticism of the Case

Below we number all sections as they appeared in Fan & Zhang's comment and reply to their specific critiques.

(1) 'Lack of understanding of the Code and disregard of its rules by authors of Case 3501'.

1.1. Article 75.4 was cited as 'violated'. This Article states 'The first neotype designation . . . is valid and no subsequent designation, *except one made by the*

Commission . . ., has any validity . . .' [italics ours]. Our petition specifically seeks such a subsequent neotype designation under the plenary power of the Commission directly in accordance with Article 75.4.

1.2. Article 80.9 was cited as 'violated'. This Article states 'Previous decisions of the Commission. No ruling given by the Commission . . . is to be set aside without the consent of the Commission'. Specifically in accordance with Article 80.9, we seek the consent of the Commission to set aside its previous decision on the neotype of *Acarus putrescentiae*.

1.3. Fan & Zhang also criticized us for designating neoparatypes (p. 99). However, our petition does not designate neoparatypes nor even mention them. Neoparatypes are not regulated by the Code, hence are irrelevant to the issue.

(2) 'Lack of sufficient evidence for 'prevailing usage' in Case 3501'.

To determine prevailing usage of the name *T. putrescentiae*, in 2007–2009 we conducted a survey of works using this name and published over the preceding 20 years, requesting authors of 49 of these works to allow us to examine their specimens. Of these, the authors of 31 works sent their specimens. Other authors reported that their vouchers were lost or not saved, and some authors responded that they no longer worked in acarology or did not respond at all. Thus, it was impossible to conduct an exhaustive study (as suggested by Fan & Zhang). Because all of these published works were treated equally (i.e. no selection bias), our survey is both representative and instructive in estimating prevailing usage. The result: 30 works (14 authors) actually published on *T. putrescentiae* and one work actually on *T. fanetzhangorum*.

Below we discuss more specific criticisms presented in this section.

2.1. 'They did not mention that Fan & Zhang (2007b) examined some 60 [actually only 26 listed] specimens [of the rare species] available to them' (p. 100) and the lengthy list of distributions of both species on pp. 100–101. This criticism is irrelevant to the Code definition of prevailing usage. Prevailing usage is defined as usage by 'a substantial majority of the most recent authors', not based on specimens examined or geographic distribution.

2.2. 'For hundreds of studies on *T. putrescentiae*, a sample of 31 published studies by 14 authors is a very small minority' (p. 100). The Glossary of the Code defines prevailing usage of a name as: 'that usage of the name which is adopted by at least a substantial majority of the most recent authors concerned with the relevant taxon, irrespective of how long ago their work was published'. We do not consider our verifying the usage of *T. putrescentiae* in 30 of 31 cases in the past 20 years out of 49 attempts as representing 'a very small minority'.

2.3. Fan & Zhang argue that we did not demonstrate prevailing usage because our survey was 'biased' by papers based on 'laboratory-reared material'. This is not a bias but a reflection of the real situation. *T. putrescentiae* is widely used in various molecular, medical, immunological, and pest-control studies that rely on pure cultures reared in a standardized manner in a laboratory (rather than collected from environmental samples). Not surprisingly, usage of this name in these papers is much more frequent than in taxonomic ones. We note that this argument is somehow ironic because Fan & Zhang's name '*T. communis*' is also based on specimens from a laboratory culture.

2.4. Although the issue of whether *T. putrescentiae* is more common in nature than *T. fanetzhangorum* is irrelevant to determining prevailing usage, Fan & Zhang challenge this, unfortunately providing no supporting evidence. Because in the text we use 'common' for *T. putrescentiae* and 'rare' for *T. fanetzhangorum*, we give reasons for such definitions here: (i) in our collection (UMMZ) there are nine 100-slide boxes with *T. putrescentiae* and only one box (two collection localities, fewer than 20 slides) for *T. fanetzhangorum*; (ii) the specimen count for *T. putrescentiae* (= *communis*) is 355+ as against 26 for *T. fanetzhangorum* in the *Tyrophagus* monograph (Fan & Zhang, 2007); (iii) *T. putrescentiae* was included in the latest key to stored product and house dust mites, but *T. fanetzhangorum* was not, despite its author's awareness of the name (Solarz, 2012), indicating its low or negligible prevalence as compared to *T. putrescentiae*.

In conclusion, we do not think our sample was biased or insufficient regarding the recent published literature, which is the point of contention with respect to Code application. It was not our point that our *T. putrescentiae* was more 'common' in nature (although evidence suggests it is), only that we verified that the name was applied to the single ('common') species by the overwhelming majority of recent authors, thus constituting prevailing usage.

(3) 'Inaccurate perceptions of presumed disruption to stability by authors of Case 3501'. The case of *Varroa destructor* versus *Varroa jacobsoni* was given as an example where a community accepted a name change following revision of species concepts. However, in this example both names are valid. In our case, one of the names, *T. communis*, is invalid (a junior synonym), and there is uncertainty with respect to choosing the oldest available junior synonym of (the common) *T. putrescentiae* should that name be applied to the rare species. Moreover, unlike the case of the *Varroa* species, which parasitize different host bees in different geographic regions, the identity of the common and rare species cannot be deduced from their habitats but only from their morphologies or DNA sequences. Thus, changing the concept of *T. putrescentiae* will create a large-scale nomenclatorial conundrum and result in great instability (see the section 'Fan & Zhang's solution' above).

(4) 'Misinterpretations by the authors of this case of the work of Fan & Zhang (2007a, b)'

Here Fan & Zhang refer to 'misinterpretations' of their two published works, however, in their comment specifically referring to the names *T. americanus*, *T. breviceps*, *T. cocciphilus*, and *T. castellanii,* they refer to unpublished data (without specifying their nature). The nature of their unpublished evidence can be seen from Dr. Fan's message distributed to the Acarology listserv on Jul 12 2009: 'According to our study of the specimens (*Tyroglyphus americanus* Banks, 1906; *T. breviceps* Banks, 1906; *T. cocciphilus* Banks, 1906; *T. sacchari* Banks, 1906 [sic], the conditions of these specimens were not ideal, even after re-mounting), at that moment we could not conclude that they were conspecific; therefore, we retained names. Therefore, it is better to retain these names until we are capable of resolving the problems.'

The type series of these species were originally mounted in Canada balsam (a hydrophobic medium with a poor refractive index for mites), and for that reason, it was impossible to study them in the detail necessary in that state. Our subsequent examination of these specimens indicated someone had attempted to remount them in an aqueous medium (Hoyer's), but the attempt resulted in damage to the

specimens. However, as we indicated in our publication (Klimov & OConnor, 2009a), there were multiple syntype slides, and we were able to dissolve the original mounting medium of representatives by consecutive xylene/ethanol washes and then successfully remount them in Hoyer's. This produced excellent specimens, with all diagnostic characters clearly visible. Based on the remounted specimens, we designated lectotypes, synonymized *T. americanus*, *T. breviceps*, and *T. cocciphilus* with *T. putrescentiae*, and provided microscope photographs illustrating the diagnostic characters in the remounted specimens (Klimov & OConnor 2009a; BZN **67**: 24–27). Regretfully, Fan & Zhang (BZN **71**: 99–102) did not comment on this critical synonymy (likewise our synonymy of other taxa, except for *T. amboinensis*) that make *T. communis* Fan & Zhang a junior synonym and thus invalid.

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