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THE GENUS *SCIRTOTHRIPS* (THYSANOPTERA: THRIPIDAE) IN MEXICO: A CRITIQUE OF THE REVIEW BY JOHANSEN & MOJICA-GUZMAN (1998)

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ABSTRACT. A recent taxonomic review of *Scirtothrips* in Mexico by Johansen & Mojica-Guzmán recognised 37 species, of which 32 were described as new species. Of these species 21, including 18 new species, were recorded from *Mangifera*, and seven, of which five were new, were recorded from *Persea*. Some of these species were discriminated on the grounds of minor differences in the arrangement of setae on the pronotum. We suggest that at least some of these 'species' are invalid, because the arrangement of pronotal setae is highly variable in several common pest species. For entomologists in Mexico, there are two reasons to re-evaluate these 'species'. A large suite of congeneric species co-existing on a single host-plant is remarkable, particularly as this situation presumably involves a host-shift from native plants to the non-native mango. A large number of similar looking pest species co-existing on and damaging high-value fruit crops poses several problems in economic entomology, including the potential effect of quarantine restrictions on the Mexican export trade.
KEY WORDS: Quarantine pest, thrips variation, mango avocado.

RESUMEN. En una revisión taxonómica reciente de *Scirtothrips* de México, Johansen y Mojica-Guzmán reconocieron 37 especies, de las cuales 32 se describieron como especies nuevas. De estas especies, 21 se registraron en *Mangifera* incluyendo 18 nuevas especies, y siete se registraron en *Persea*, de las cuales cinco fueron nuevas. Algunas de estas especies se discriminaron con base en diferencias menores del arreglo de las sedas sobre el pronoto. Sugerimos que al menos algunas de estas 'especies' son inválidas debido a que el arreglo de las sedas pronotales es altamente variable en varias especies plaga comunes. Para los entomólogos de México hay dos razones para reevaluar estas 'especies'. Resulta notable que una larga serie de especies congenéricas coexistan en una sola planta huésped, en particular en esta situación en la que presumiblemente se involucra un cambio de huésped de plantas nativas al exótico mango. El que un gran número de especies plaga similares coexistan en y dañen a cultivos frutales de alto valor plantea varios problemas en entomología económica, incluyendo el efecto potencial de restricciones cuarentenarias en las exportaciones mexicanas.
PALABRAS CLAVE: Plaga cuarentenada, variación, trips, mango, aguacate.

All biologists, whether in crop protection or in academic studies, rely for efficient communication of their observations and results on the names, identification systems, and predictive classifications provided by taxonomists. The primary objective of taxonomic work is to facilitate this communication, by providing accurate identification systems, efficient sets of names, and a systematic framework that indicates the evolutionary relationships between organisms. The objective of this critique is to draw to the attention of biologists in central America, particularly those in the agricultural and entomological communities, the scientific and economic implications of a recent taxonomic account of the genus *Scirtothrips* from Mexico. We question some of the assumptions, techniques and conclusions in that paper, which is concerned with a genus that, worldwide, includes some of the most serious insect pests of agriculture. We emphasise that this is not merely an academic disagreement between specialists, because of the wide ranging implications in biological science, in agricultural economics, in crop protection, and in trade politics.

The paper that we question was published by Roberto M. Johansen and Aurea Mojica-Guzmán (RJ & AM) in *Folia Entomologica Mexicana* (104: 23-108), and records 37 species of *Scirtothrips* from Mexico, 32 being described as new species. Given the ecological diversity of Mexico, the discovery of a large number of congeneric insect species is not in itself surprising. However, RJ & AM record a total of 21 members of this genus from mango trees (*Mangifera indica)* in Mexico, 18 of these being described as new species. This plant is not native to the Americas. Thus, although each of these new species is stated to cause damage to mango trees in Mexico, each must have some other, unrecorded, native host-plant in the area. Similarly, seven *Scirtothrips* species are recorded from avocado trees (*Persea americana)*, of which five are described by RJ & AM as new species. Although this plant is native to Central America, an hypothesis that it supports a co-existing suite of congeneric species raises interesting evolutionary, as well as economic, questions. It should be noted that RJ & AM do not consider the possibility that any of their 'new species' have been introduced from some other country.

The existence of a large number of structurally similar species in a single area, and on one species of host-plant, would be an evolutionary phenomenon worthy of further study. In these circumstances, modern biology expects a taxonomist to provide collateral evidence to support such an interesting set of taxonomic hypotheses. This, however, RJ & AM singularly fail to do. Each of the species is distinguished on one or a few structural features, and no supporting evidence is provided for the suggestion that any of the structural segregates recognised is a biological species. Indeed, certain of the structural features on which RJ & AM rely heavily for distinguishing between their species are known to be highly variable within populations of pest species of *Scirtothrips* in other parts of the world, as indicated below. The situation therefore raises a series of questions, with extensive implications for pest management, pest biology, and crop protection in Mexico.

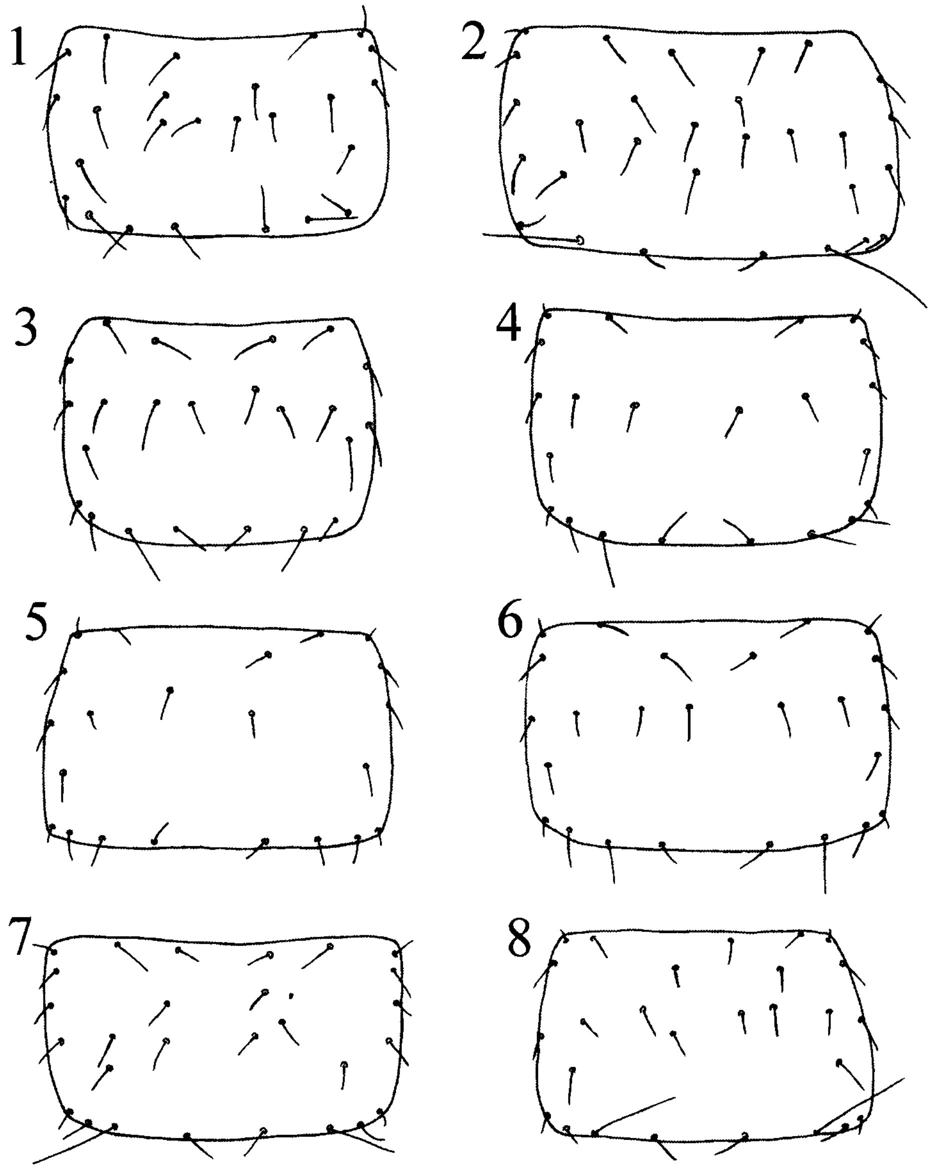
If there is a large suite of co-existing species in the genus *Scirtothrips* in Mexico, what are the relationships of these species to their native host plants and to the two tree crops, mango and avocado? That is, what percentage of the total population of any one of these species exists on its unknown native host plant, and what percentage on one of the tree crops? Is the presence of these species on the tree crops a reflection of a population surge on some native host-plant? What differences are there in the phenology of each of the thrips species, and in its suite of natural enemies? Perhaps most important, what effect does such an extensive suite of pests have on crop losses, crop protection, and crop marketing, given increasing stringency of quarantine barriers?

These questions range beyond the sphere of taxonomy, but they are dependent entirely on that branch of study, being based on the taxonomic hypothesis that a large number of congeneric species exists on these two tree crops in Mexico. Although we have not studied the specimens used by RJ & AM, we give reasons for suspecting that the criteria they used for distinguishing between species are not all satisfactory. The scientific problem is one of field biology, requiring suitable population sampling methods of breeding populations to establish ranges of variation. We can only draw attention to the problems, in the hope that biologists in Mexico will consider them an appropriate subject for further study.

CRITICISM 1: Assessment of character states

Johansen & Mojica-Guzmán place great significance on the number and arrangement of setae on the median area of the pronotum in *Scirtothrips* adults. To describe these setae, they use the terms 'anteromarginal' or 'subanteromarginal', and 'median' or 'displaced', also they refer to a transverse setal row as either 'continuous' or with 'median gap'. However, they fail to provide any clear definition of these character states (see Figs 1, 2; these being copies of Figs 8 & 148 from Johansen & Mojica-Guzmán). Clear differences in the position of these setae can be seen in only a few of the appropriate illustrations in their paper, and the homologies involved are left to the reader to conjecture. Despite the lack of clarity in defining character states, RJ & AM use small differences to erect not only new species but new higher level groups. For example, the '*S. longipennis* assemblage' is defined as including those species that lack setae medially on the pronotum ('almost glabrous at center').

Some of the most serious problems arise with variation in the placement and number of the pronotal setae in species of the '*S. citri* assemblage'. According to RJ & AM, *S. perseae* has the pronotal median setae in a continuous transverse row, and is distinguished from their new species *S. aguacatae* by having four median setae (Fig. 3; this being a copy of Fig. 10 from Johansen & Mojica-Guzmán), versus three in *S. aguacatae*. *S. perseae* is a common pest of avocados in California, where it appeared suddenly in June 1996, and dispersed rapidly from an initial infestation in a single orchard (Hoddle & Morse, 1998a). Within Californian populations of *S. perseae* (Figs 4-6), the number of setae medially on the pronotum varies from 1 - 6 in females and from 0-4 in males. If RJ & AM are correct in their character assessment, then the



Figs 1-8. Arrangement of pronotal setae in *Scirtothrips* species. 1, *tacambarensis* (redrawn from J. & M-G. Fig 8). 2, *mangoaffinis* (redrawn from J & G-M Fig 148). 3, *perseae* (redrawn from J. & M-G. Fig 10). 4 - 6, *perseae*, ex- California, USA. 7 - 8, *citri*, California, USA.

pest on avocado trees in California would comprise a series of species. However, extensive field studies on the phenology of *S. perseae* in California by Dr Mark Hoddle at the University of California, Riverside, supported by laboratory work on the developmental and reproductive biology of the pest (Hoddle & Morse, 1998b), indicate that only a single species is involved.

Variation in the arrangement of the pronotal median setae in *S. perseae* is substantiated by a study of 24 females and four males collected on avocado in Uruapan, Michoacan, Mexico, from where much of the material studied by RJ & AM was collected. These specimens cannot be differentiated from the *S. perseae* types and other identified material from California. Amongst the females, one specimen has 1 median seta, eight have 2 setae, four have 3 setae, and 11 have 4 setae. Moreover, 12 females and four males collected on avocado from other states in Mexico agree with Californian material of *S. perseae*, but show the following variation in the pronotal setae: two females with 1 median seta, three with 2 setae, four with 4 setae, one with 5 setae, and two with 6 setae; one male with 2 setae, one with 4 setae and two with 5 setae. Also variable in the specimens examined from California and Mexico (Figs 4-6) is the number and placement of the pronotal submedian anteromarginal setae. If RJ & AM consider that diverse arrangements of pronotal setae indicate different species, then they need to provide collateral biological or morphological evidence to support their opinion.

According to the identification keys provided by the UNAM authors, specimens with 0 or possibly 1 median pronotal seta would belong in the '*S. longipennis* assemblage' not in the '*S. citri* assemblage'. However, we have examined 17 females that we consider to represent *S. longipennis*, preserved in the collections of the major international museums in London, Frankfurt, Washington and Canberra,. These specimens came from different parts of the world, and their identification as this species is based on comparison with syntypes and the character states given in the redefinition of this species by Mound & Palmer (1981). The number of median pronotal setae on these specimens varies as follows: 2 females with 3 median setae; 12 females with 2 median setae (including one syntype); 2 females with 1 median seta; 1 female with 0 setae medially. Most of these specimens would not be placed in the '*S. longipennis* assemblage' using the RJ & AM keys, but in their '*S. citri* assemblage'. Furthermore, Figure 99 of RJ & AM is of a specimen with a pair of setae within the ocellar triangle on the head, whereas *S. longipennis* Bagnall as interpreted by other authors has the ocellar setae arising outside the ocellar triangle (Mound & Palmer 1981).

Females of *Scirtothrips citri* from citrus trees in California, have the number of median pronotal setae varying from 3-6. These may be in a single transverse row, or with one or more setae displaced anteriorly or posteriorly from this transverse row

(Figs 7, 8). Specimens in which one or more setae are displaced cannot be identified to the '*S. citri* assemblage' in the RJ & AM key. According to their list of material, they examined only one female of this major pest, and their Figure1 illustrates four setae in an irregular transverse row. Furthermore, their Figure 77 of female tergites VIII-X does not illustrate the median microtrichia on abdominal tergite VIII and IX that occur in this species.

Adults of species in the genus *Scirtothrips* all bear a pair of small setae on the head just in front of the first ocellus. Considerable emphasis is placed by RJ & AM on the length of these short, anterior setae relative to the posterior ocelli. Although the presence or absence of this pair of setae is taxonomically useful, their length is rarely reliable enough to use as a discriminant. In members of the family Thripidae, the anterior area of the vertex of the head, on which this pair of setae arises, slopes downward. These setae thus do not lie horizontally, except on crushed specimens with the head dorsally flattened, but stand up vertical or variously slanted, and moreover they are commonly curved. Their apparent length is thus not their true length, and this character state is thus an unreliable discriminant.

The lack of substantiating morphological character states is a worrying feature of the new species descriptions. RJ & AM give inadequate information on characters used in recent treatments of species in this genus (Mound & Palmer 1981; Nakahara 1997; zur Strassen 1993), particularly the characterisation of abdominal structures: distribution of sternal microtrichia, size and placement of tergal median setae, number of discal setae on tergal microtrichial fields, distribution of median tergal microtrichia on VIIII and IX (for some species), and sternal colour. As a result, for example, it is not clear from the RJ & AM description how their new species *S. manihotifloris* differs from *S. manihoti*, a widespread pest on manihot from Central America to southern Brazil.

CRITICISM 2: Microslide preparation techniques.

The lack of a full range of morphological characters in the descriptions by RJ & AM possibly results from the techniques they use for microslide preparation. The drawings associated with their species descriptions are careful and precise, but from these it is evident that their specimens are sometimes distorted during chemical treatment, or insufficiently cleared for certain fine details to be studied accurately. For example, it is evident from Figure 88 that the holotype of *S. musciaffinis* is uncleared and crushed laterally. Unless specimens are adequately cleared and mounted without distortion, structures such as microtrichia on the sternites and on tergites VIII-IX, also sculpturing in the interocellar area, are difficult or impossible to observe. The uncleared and distorted slide preparations of earlier workers, such as Dudley Moulton, Stanley Bailey and Richard Bagnall, severely limit observations on critical character states that are needed for present day research. Modern workers such as Jitendravir Bhatti, Iwao Kudo, Jennifer Palmer and Shuji Okajima, recognising the limitations placed on taxonomic deduction by inadequately mounted specimens, have far advanced the technical standards expected in thrips microslide preparation.

CRITICISM 3: Biology and host-plant data.

The data given by RJ & AM indicates that many of the specimens on which their new species are based were collected together. On two separate dates (9 & 24.iii.1998) a total of 13 *Scirtothrips* species were collected from *Mangifera indica* at a single site (El Guaco). Moreover, on another date (10.ii.1998) a total of 10 species were collected from this plant species at that site. From these three collections 20 of the 21 species that they list from *Mangifera* were distinguished, including 17 of the 18 new species described from this host. This tropical fruit tree is introduced to Mexico, hence the thrips must have native host plants on which they normally breed (unless one or more is introduced from another country).

To establish the correct host plant of a thrips species, that is the plant on which its larvae will develop, and also to ensure that males and females of each species are correctly associated, it is essential to carry out repetitive collecting, or careful breeding studies. Arbitrarily associating sexes on the basis of one or two structural details, from a mixed sample of many different species, is not a satisfactory technique. Considering the variation in pronotal setae noted above in *S. citri*, *S. longipennis* and *S. perseae*, similar variation is to be expected in the species described from *Mangifera*, and the validity of these new species requires confirmation with further biological and morphological data.

RJ & AM mention, in their Abstract, that one of these *Scirtothrips* species is associated with 'agroecosystems of Poaceae like *Avena sativa*'. Such a host-relationship would be of considerable interest, because worldwide no *Scirtothrips* species is known to be associated with any type of grass. However, from the main text it is clear that RJ & AM had only a single female from this plant. Since thrips distribute widely on the wind, most thrips workers realise that finding a single individual is no indication of a host relationship. Indeed, mass flights are common amongst some thrips species, and on such occasions very large numbers of adults can be found on plants on which they do not breed. Thus, it is not possible to adduce that a plant is a host merely because one thrips adult is collected on it. Indeed, Mound & Marullo (1996: 17) noted 'many thousands of thrips of several species' on the flowering spike of a *Miconia longifolia* bush in Costa Rica. But these thrips were on that bush for only one day, and the vast population produced no larvae on the bush, so that this was not a true host-plant relationship. Despite these problems in defining the true host-plant relationships of thrips species, RJ & AM name one of their new species *S. musciaffinis* ('fond of mosses') simply because a solitary female was taken on an unidentified moss. Again, if correct, such a host association would be unique within this genus worldwide, and thus needs further substantiation.

One *Scirtothrips* species previously reported from Mexico is not mentioned by RJ & AM, *Scirtothrips aceri* (Moulton) having been reported from avocado in Michoacan by Coria (1993). This species belongs in the '*S. aztecus* group' as defined by RJ &AM, and its host plant in California and Arizona is *Quercus* (Nakahara 1997).

CRITICISM 4: Nomenclature.

Names are essential for communication between biologists, and names of species need to be clear and concise. The International Code of Zoological Nomenclature (1999), in Recommendation 25c, suggests that names be 'chosen with their subsequent users in mind', and that they should be 'appropriate, compact, euphonious, memorable...'. However, our Mexican colleagues do not seem to recognise the responsibilities that they owe to the rest of the biological community. Many of the new names that they propose are not compact, but exceptionally long, thus increasing the possibility of incorrect spellings by subsequent users. Moreover, many of the new names are similar to each other in construction, and are thus liable to misinterpretation by future users. Both of these problems are important in economic entomology. For example, nine of the new species from mango have names based on that fruit – *admangiferaffinis*, *mangiferaffinis*, *mangoaffinis*, *mangofrequentis*, *mangoinfestans*, *mangomolestus*, *mangorum*, *mangonoxius* and *novomangorum*. RJ & AM state that each of these species causes damage to mangos. The problems for pest control workers of keeping the different spellings accurate, and of communicating about the pest status of each such species with similar names, will be considerable.

IMPLICATIONS: Plant protection and quarantine.

The lack of information concerning the native host plants of the *Scirtothrips* species described by RJ & AM creates problems for economic entomologists, both inside and outside Mexico. RJ & AM state that all 21 of the species that they list from mango trees are associated with damage to those plants, although the basis for this deduction is unclear considering that the various species were taken together. If this large number of congeneric thrips species really does exist on Mexican mango trees, and these are causing economic losses, then some form of control strategy is presumably required. But should such a strategy focus on the mango trees, or should it include, or even target, surrounding native plants? This will depend on the size of the population of each species on its own natural host. Establishing the identity of these hosts, and the population levels of the particular *Scirtothrips* species they support, will require extensive and detailed field-work. Economic entomologists outside Mexico will also have problems with the existence of such a large number of pest thrips on fruit produced for export. RJ & AM do not seem to have considered the plant quarantine problems that the situation they appear to recognise is likely to create. Certainly, no country is likely to want to import such a crop from Mexico if there is a risk that it bears a large suite of potentially pestiferous species. This is particularly important considering that many of these thrips species must have host-switched once already, in order to be attacking a non-native plant such as mango. Similar problems are likely to arise with the suite of species RJ & AM recognise from avocado trees.

GENERAL COMMENTS

In preparing this critique we accept that every scientist must be free to make independent assessments of any situation that they research, and in general we would keep taxonomic disagreements within the framework of the technical literature. This has been our practice previously when we have felt unconvinced by taxonomic decisions published by RJ & AM, particularly in genera that have limited interest to other biologists. The only generalised public comment has been '[Johansen's] taxonomic decisions are often at variance with those of other specialists' (Mound & Marullo, 1996).

As taxonomists however, we also consider that we have particular obligations to the rest of the biological community, and specifically to economic entomologists who need help with the identification and names of pest thrips. For many years we have studied variation within and between species of insects, particularly thrips, including extensive field studies in all continents and on a wide range of crops and habitats. The RJ & AM conclusions with these *Scirtothrips* species are at variance with our experience. We hope that the points we raise will encourage Mexican entomologists to re-appraise the species status of the *Scirtothrips* on mango and avocado trees. This will not be easy, because it will require the study of structural variation in carefully mounted samples, both from natural populations and reared series on native host-plants, together with collateral biological data. We suggest that taxonomic decisions are often far too important to other biologists to be left solely to descriptive taxonomists.

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