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IMPORTANCE OF TAXONOMY IN BIOLOGICAL CONTROL

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Abstract—Taxonomy is the starting point of any basic or applied biological research. In biological control work, the pest species, its probable area of origin, and, consequently, the location where promising natural enemies may be found, are identified. The close co-operation of taxonomists during pre- and post-release surveys of natural enemies in target areas helps to indicate the indigenous fauna present and the progress of a biological control programme. Biological control programmes should budget for appropriate taxonomic studies in areas where the local fauna is poorly known. Instructing local researchers on the correct collection, preservation, and identification of relevant indigenous and exotic species should be emphasized.

Key Words: Taxonomy, classification, identification, biological control, biosystematics

Résumé—La taxonomie est le point de départ de toute recherche biologique fondamentale ou appliquée. Dans le cadre de la lutte biologique, son étude permet, lorsqu'elle est correctement menée, d'identifier les différentes espèces de ravageurs, leur lieu d'origine éventuel et, par conséquent, les sites où l'on a le plus de chance de trouver des ennemis naturels prometteurs. La collaboration étroite des taxonomistes au cours des enquêtes antérieures et ultérieures aux lâchers d'ennemis naturels dans les zones cibles permet d'évaluer la réussite du programme de lutte biologique. Dans les régions où l'on possède peu de données précises sur la faune locale, les programmes de lutte biologique doivent prévoir dans leur budget une étude taxonomique. L'importance de la formation, au niveau local, de chercheurs aptes à identifier les espèces indigènes et exotiques devrait être soulignée.

Mots Cléfs: Taxonomie, classification, identification, lutte biologique, biosystématique

INTRODUCTION

Taxonomy is the theory and practice of classifying organisms. The term classification has two different meanings: the product of the activity of the taxonomist and the activity of classifying, which consists of ordering populations and groups of populations (taxa) at all levels by inductive procedures (Mayr, 1969). Identification consists of placing individuals into previously established taxa by deductive procedures.

This field of research is of utmost importance for any area of basic and applied biology, and without it scientific communication among biologists would be severely limited.

Biological control specialists recognize the importance of taxonomy as a starting point for the introduction, conservation and augmentation of natural enemies, as extensively discussed by several authors (Clausen, 1942; DeBach, 1974; Eickwort, 1983; Schlinger and Doutt, 1964; Smiley and Knutson, 1983).

The purpose of this paper is to show the relation between biological control work and taxonomy, the reasons for limitations that might exist in identification services, and some possible approaches to reduce those problems.

ROLE OF TAXONOMY IN BIOLOGICAL CONTROL EFFORTS

Any biological control project requires continuous co-operation between biological control specialists and taxonomists. The need for co-operation starts with the proper identification of the target pest. Incomplete or wrong identification of the pest may lead to the wrong determination of its place of origin, where efficient natural enemies are expected to be found. This can result in considerable amounts of money and time spent without obtaining useful results.

One of the best examples of the consequences of improper identification of a pest species was a project for the biological control of the coffee mealybug in Kenya (LePelley, 1943; DeBach, 1974). This mealybug, *Planococcus kenyae* (LePelley), was first considered to be the citrus mealybug, *Pseudococcus citri* (Risso), and later to be *Pseudococcus lilacinus* Ckll. For this reason, 12 years were spent in exploration and introduction of the wrong natural enemies from four continents. The ultimate success of this project was achieved after it was evident that the coffee mealybug was a species distinct from *P. lilacinus*, which led to the importation of *Anagyrus* sp. near *kivuensis* Compère from nearby Uganda, where *P. kenyae* was present but rare.

In a biological control project, surveys of the area where natural enemies are supposed to be released will indicate the native species present. A comparison of the complex of natural enemies in that area and in other areas where the pest also occurs but is not a problem will help the biological control worker to select the natural enemies that show the most potential for trial introductions. A major contribution is

provided at this point by the taxonomist through identification of the candidate natural enemies. The available literature on the identified species gives the biological control worker some indication of the natural enemies' expected behaviour based on historical evidence about the particular family, genus or species.

After introduction of natural enemies, it is important to monitor their activity and establishment by periodic evaluations of the population dynamics of the particular pest and its introduced natural enemies. Here again the co-operation of taxonomists in determining the different species is important. A comparison of the pre- and post-release surveys should be encouraged since any change in the fauna may be indicative of the progress of the programme.

But the work of taxonomists goes beyond naming new species or identifying species already described. It also considers the relationship between species, seeking to arrange them in meaningful groups. This is important for biological control workers for several reasons, especially in determining places of origin of pests. Furthermore, the work of taxonomists takes into account the biological differences between populations of a same species that indicate the occurrence of biotypes, which are populations of individuals of similar genetic composition for a biological attribute (Gonzalez *et al.*, 1979). When studying the potential of a particular natural enemy, the adaptability of distinct biotypes to different ecological conditions, as identified in taxonomic comparisons of population of a same species from different areas, is also important to biological control workers.

Reference collections prepared by taxonomists are of major importance not only for ongoing, but also for future biological control projects. Those collections should include both native and introduced species. In the case of natural enemies, specimens originally introduced and their laboratory and field offspring (collected at different periods) should be preserved for studies of possible morphological alteration in the new environment. Reference collections may provide hints to places of origin of different organisms. A good example of this was reported by Pemberton, as mentioned by Clausen (1942). A single specimen present in a private collection at Sydney was the clue that led Pemberton to discover the place of origin of the fern weevil, *Synagrius fulvitarsis* Pasc., a serious pest in Hawaii. This ultimately resulted in the introduction and establishment of a natural enemy from Australia (Clausen, 1978).

Reference collections are also helpful for local researchers, making it possible for non-taxonomists to have an idea of the identity of specimens collected locally, by comparing them with specimens available in the collection.

In addition, taxonomists gather information on the distribution and habitat of different species. When facilities are available, these data can be computerized and made available to workers in biological control as well as in other specialities.

METHODS USED BY TAXONOMISTS AND MATERIALS NEEDED

In a biological sense, species are groups of actually or potentially interbreeding natural populations that are reproductively isolated from other such groups (Mayr, 1969). This concept is not based on phenotype and thus allows for considerable variation as long as the groups of organisms that are called species maintain their individualities as "reproductive units". Taxonomists that advocate the biological concept of species may make use of morphological characters to separate them, however, there is a fundamental difference between using morphological characters to infer reproductive affinities and basing the species concept on morphology (Simpson, 1961).

In many cases, morphological evidence alone is not sufficient to separate organisms into species, because of variations presented by conspecific individuals as well as similarities presented by sibling species. In those cases, field ecological observations, laboratory crossings or other biological studies are necessary to indicate whether one is dealing with a single or more than one species. For instance, studies of the variation of morphological characters within and between species of predatory mites of the family Phytoseiidae have shown considerable variation within one species according to geographical distribution, season and host plant (Chant *et al.*, 1977; Croft, 1970; Davis, 1970; Hoying and Croft, 1977; Muma and Denmark, 1962), whereas great similarities have been found in closely related sibling species (Muma and Denmark, 1969).

The simple rearing of organisms in the laboratory for subsequent morphological studies often shows the variations to be expected in a particular species. Thus, the tools of taxonomists are not restricted to microscopes, mounting material, cabinets for preserving specimens and the literature related to their specialty, but must also include collecting material and laboratory facilities for biological studies.

For example, a species in need of detailed biosystematic study at the present time is the predaceous phytoseiid mite, *Typhlodromalus* sp. near *limonicus* (Garman & McGregor). This is one of the most common species on cassava in Colombia, and is potentially important as a predator of cassava green mites, *Mononychellus tanajoa* (Bondar) *sensu latu*, in Africa. It is morphologically similar to *T. limonicus* and *T. rapax* (DeLeon) (the former described from California, USA, and the latter described from Puerto Rico), but still presents some differences that indicate that it is an undescribed species. Laboratory crossing studies and evaluation of morphological variation in populations reared under controlled laboratory conditions may be helpful to indicate the identity of the Colombian species.

FIELD STUDIES

The biological concept of species does not allow the taxonomists to rely on only a few preserved museum specimens to classify or identify species. Sound information on field ecology, which often cannot be expressed in the labels attached to each specimen, is of major importance to a taxonomist. If this type of work cannot be conducted directly by a taxonomist, personal communication with the scientists most directly interested in the identification is extremely helpful.

The initial identification of the cassava mealybug is

an excellent example of the importance of communication between the taxonomist and the interested scientist. Field observations conducted by biological control workers and laboratory rearings indicated that the external appearance and biology of the mealybug from Africa differed considerably from that found in northern South America and some Caribbean islands (Cox and Williams, 1981). Most markedly, those from Africa were pink and parthenogenetic and those from northern South America and the Caribbean Islands were yellow and bisexual. After the discovery of those facts, other characters were found to vary consistently between populations originating from the two continents. Thus, that from Africa *Phenaccocus manihoti* Mat.-Ferr. was considered to be a species different from that from northern South America and the Caribbean Islands (*Phenacoccus herreni* Cox and Williams). Today, *P. manihoti* is also known to occur in Bolivia, Paraguay and southwestern Brazil (Yaseen, 1986).

NEED OF SUPPORT FOR TAXONOMIC WORKS

Taxonomy may assist biological control activities in several ways, as shown above. However, to be of assistance, a taxonomist must have had an opportunity to work out taxonomic problems in the target area or have had an opportunity to identify where a taxonomic problem exists. Very often, biological control projects are undertaken in areas where the fauna is poorly known. Under those conditions, as far as possible, the projects should consider in their budgets a fund for taxonomic studies, which include collection of specimens and morphological and biosystematic observations. Such studies are frequently necessary before the positive identification of a particular species can be provided.

Sufficient support should be available to enable taxonomists to prepare monographs, identification keys and catalogues to facilitate the work and also make the day-to-day identification of the most common species possible by non-taxonomists.

DISCUSSION AND CONCLUSION

While DeBach (1974) does not support long-term basic ecological research before the actual introduction of natural enemies in a biological control project, this should not suggest that monitoring is unnecessary. Without monitoring, biological control work would represent a simple trial and error approach devoid of any scientific base. As stated by DeBach (1974), biological control is dependent to a large extent on ecological research, which is necessary to determine whether emphasis should be placed on importation, conservation or augmentation of natural enemies. Taxonomy plays an important role in all phases of the biological control programme, beginning with the identification of the target pest.

Very often, biological control workers need the identification of a particular species in a very short time. Limiting factors to a fast identification may be unresolved taxonomic problems and/or the absence of a taxonomist near where the species was collected. An approach to the first factor mentioned is to provide funds for necessary taxonomic studies. An approach to the second factor is to invest in training local researchers with some inclination to taxonomy, so as to develop a functional capability in identifying local species, which could then be periodically verified by taxonomic experts (Yaninek, 1984).

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