TAXONOMIC RESEARCH ON FOREST INSECTS AND DISEASES AT THE NORTHERN FORESTRY CENTRE: PART 2, TAXONOMY OF PISSODES WEEVILS

by
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Introduction

In part 1 of this series of articles describing ongoing taxonomic research at the Northern Forestry Centre, I briefly introduced the basic principles of taxonomy, summarized the tools (character systems) that scientists use to solve taxonomic problems, and outlined some of the results and benefits of taxonomic research (FID Notes, Dec. 1990). In part 2, I will outline my research on the taxonomy of bark weevils and terminal weevils in the genus Pissodes, summarize some results, and discuss the overall goals and benefits of this study.

The Genus Pissodes

Weevils in the genus Pissodes are native to North and Central America, Europe, and much of Asia. Their distribution coincides with that of conifers which they utilize for food and breeding. There are currently 30 species recognized in North and central America and 16 in Europe and Asia. Eleven species are found in the prairie provinces (Table 1). Most species have little economic impact on forests but a few species cause serious damage to conifers, e.g. P. strobi and P. terminalis in North America, P. castaneus in Europe and Asia, and P. nitidus in China. The most serious pests tend to be those which kill tree leaders (strobi, terminalis, nitidus), which leads to stem deformations and tree devaluation.

Most of the bole and root-collar inhabiting species are secondary and attack trees that were weakened or killed by other agents.

The taxonomy of Pissodes has never been studied on a global level. A. D. Hopkins treated the North American species in 1911 and subsequently several scientists studied parts of the genus or described new species. However, there are still many confusing taxonomic problems within Pissodes in both the Old and New Worlds which demand attention. In 1989, I began a study of the taxonomy of Pissodes. Although elucidation of local (Canada) taxonomic problems in Pissodes is important, it is necessary to study the genus from a global perspective because many local species have wide distributions and significant geographic variation.

Summary of Current Research

Taxonomists have at their disposal several tools (character systems) to aid in solving taxonomic problems. It is prudent to use as many character systems as possible to solve such problems. In my study of Pissodes I use morphological (=structural), ecological, biochemical, and genetic character systems:

Morphology - Morphological characters are the most commonly used characters in taxonomic studies. When studying morphology one looks at shape, color, pattern, and number of structures on an organism. Over 15,000 specimens of Pissodes borrowed from museums around the world are currently being studied for variation in numerous morphological characters. Of particular interest are characters situated on the head and genitalia.

Ecology - Several species of Pissodes are extremely similar in morphology and are difficult to discriminate among based on morphological characters. However, these species are quite different in ecological characters such as life cycle, behaviour, etc. The life history of P. terminalis is currently being studied to help determine if the species that infests lodgepole pine is the same as the one in jack pine. In lodgepole pine, weevils take two years to complete a generation but only one year in jack pine. The taxonomic significance of this difference will be assessed in combination with other characters.

Biochemical - Differences between taxa may be evident at a biochemical level before at a morphological or ecological level. Organisms can be studied at a biochemical level using many different methods. We are using electrophoresis [technique which separates molecules according to their electric charge] to study enzyme variation in Pissodes. There is some preliminary evidence to suggest that some species of Pissodes can be discriminated based on enzyme characters.

Genetic - Most of the variation observed in morphological, ecological, biochemical, and other character systems is controlled by genetic factors (genes composed of DNA). In addition to analyzing these character systems, which reflect variation in DNA structure, it is also useful to analyze variation in DNA structure directly. At NoFC, we are in the process of creating a laboratory to analyze DNA structure of Pissodes (and other organisms) using PCR (polymerase chain reaction) and sequencing techniques. Although analysis of DNA sequences is a powerful taxonomic tool, much research is required to refine data analysis and interpretation techniques. Biochemical and genetic techniques may be most valuable in elucidating taxonomic problems in portions of the genus that are poorly differentiated morphologically.

Goals and Benefits of this Research

There are three major goals to this research on Pissodes taxonomy:

Firstly, species boundaries will be delimited and described. This involves a survey of variation in as many character systems as possible for the entire genus. The genus will then be subdivided into smaller taxonomic units [=taxa (pl.), taxon (sing.)], such as species and subspecies, each defined by a set of various character states. Each taxon will then be described based on the characters studied. If the taxon does not already have a name then a name will be assigned. Potentially, Pissodes species may become synonymyzed, i.e. what was thought previously to be more than one species may be the same species. Conversely, what was previously thought to be one species may be two or more species.

Secondly, illustrated identification keys will be constructed to aid others in the diagnosis of Pissodes species. These keys incorporate the character states used to originally define the taxa. As much as possible, morphological characters will be used to construct these keys since data from other character systems (ecological, biochemical, genetic) are rarely available to most collectors.

Thirdly, I will attempt to infer something about the evolutionary history (phylogeny) of and relationships among the various Pissodes taxa. Although this is somewhat of an academic

exercise, phylogenetic analyses can sometimes give us valuable insights into many kinds of biological relationships, e.g. insect-plant relationships and epidemiology.

Solid taxonomy is the backbone to most other kinds of research. This is certainly true of Pissodes which is in a state of taxonomic disarray. A thorough understanding of species boundaries and a means of discriminating among species is essential to most other research on these organisms and a necessary prerequisite for accurate surveys. Additionally, future management programs for Pissodes may be based on mate- and host-finding behaviour, which are presumably species-specific and under genetic control. The correct identification of species will be essential to the development and application of these pest management programs. In addition to taxonomic research on Pissodes, I am involved in research on the biology, impact, and management of economically important Pissodes species in western Canada.

Table 1. Pissodes species in the prairie provinces and Northwest Territories.

Species	Hosts	Part of tree attacked
affinis	Pinus	bole
burkei	Abies	bole
dubius	Abies	bole
fasciatus	Pseudotsuga	bole
fiskei	Picea	bole
nemorensis	Pinus, Picea	bole
rotundatus	Pinus, Picea	bole
schwarzi	Pinus	bole
strobi	Pinus, Picea	terminals
terminalis	Pinus	terminals
utahensis	Abies lasiocarpa	witches brooms