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Review of seasonal polyphenism in the Symphyta (Hymenoptera), exemplified by *Pristiphora leucopus* (Hellén, 1948) (Tenthredinidae)

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Abstract

Morphological differences between the adults of overwintering and non-overwintering generations of the sawfly *Pristiphora leucopus* (Nematinae) are described and illustrated, as well as characters that distinguish *P. leucopus* from the closely similar *P. armata*. In the basal hymenopteran lineages ('Symphyta'), seasonal polyphenism is so far only definitely recorded in the Sterictiphorinae (Argidae) and Nematinae (Tenthredinidae) of the Tenthredinoidea. Within the Nematinae, seasonal polyphenism had previously only been described in *Nematus bergmanni*. Seasonal polyphenism in the basal hymenopteran lineages is reviewed, and the potential pitfall that the existence of seasonal morphs represents for taxonomists working on 'Symphyta' is highlighted. Voltinism patterns in the basal hymenopteran lineages are also reviewed, to indicate the likelihood of further undetected examples of seasonal polyphenism in the families and subfamilies. With rare exceptions, multivoltinism occurs mainly in the Tenthredinoidea and is most frequent in the Argidae and Tenthredinidae (particularly Allantinae, Blennocampinae and Nematinae).

Key words: morphs, lancet, colouration, phenotypic variability, voltinism, *Pristiphora armata*

Introduction

Phenotypic variability differs from polyphenism in mechanism as well as mode of expression (Evans & Wheeler 2001). The former is expressed as a gradient of morphological variability between extreme forms. Such variability is regarded as normal in many species throughout the animal kingdom, but in less intensively studied taxa, including most insects, is often not distinguished from genotypic variability or polymorphism. The term polymorphism now tends to be reserved for cases in which more than one genotype occurs in a species, and these genotypes are discretely different (Fusco & Minelli 2010). Polymorphism may not always be clearly reflected in phenotypic differences. Polyphenism involves morphs that show discrete phenotypic differences, without intermediates, in morphology and often also behaviour. Although all types of variability involve an interaction between environmental and genetic factors, polyphenic morphs share the same genotype (Fusco & Minelli 2010). As well as seasonal polyphenism in its restricted sense as used here, other 'special cases' of polyphenism occur throughout the Insecta, such as dispersion or wing-length polyphenism (e.g., in Gerridae (Heteroptera) and Acrididae (Orthoptera)), cyclic alternation of sexual and asexual generations (some Aphidoidea (Hemiptera) and Cynipidae (Hymenoptera)), and caste dimorphism (Isoptera and eusocial Hymenoptera) (Simpson et al. 2011). Seasonal polyphenism is widespread in many insect orders, but occurs in a small minority of species. It is manifested usually only in the adult. However, the developmental pathway to one morph or the other is determined during a more immature developmental stage, which it is often possible to specify precisely (e.g. not the entire larval stage, but only the last instar: Riley 1980). The process is controlled by the endocrine system, with one or more environmental factors acting as stimuli. In many insects the most important stimulus is day length (photoperiod), but temperature (Tsurata et al. 1989), humidity (Ruszczyk et al. 2004) and food quality (O'Donnell 1998) have also been shown to be sometimes important, either as the only stimulus, or modifying the effect of one of the others. In recent years the genetic component of polyphenism has been recognized as important, at least in

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