GENERAL BIOLOGY AND NOMENCLATURE OF *SANCASSANIA BERLESEI* (MICHAEL)

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TAXONOMY
BIOLOGY

ABSTRACT : The nomenclature and general biology of *Sancassania berlesei* (Michael) are discussed. Developmental time from egg to adult was 159 hrs on a yeast diet when reared at 25°C.

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RÉSUMÉ : La nomenclature et la biologie générale de *Sancassania berlesei* (Michael) sont discutés. La durée du développement, de l'œuf à l'adulte, a été de 159 heures sur de la levure à 25°C.

INTRODUCTION

Sancassania berlesei (Michael) is a common cosmopolitan mite frequently found in laboratories, particularly in insect cultures, in poultry litter and where foodstuffs are poorly stored. Depredations of this mite only become apparent when products are stored in extremely damp conditions, and where there would normally be spoilage due to the high moisture. At Lincoln College in 1967, a number of experimentally grown peanut plants were found to be heavily infested with an Acarid mite tentatively identified as *Caloglyphus berlesei*, a species not previously recorded in New Zealand. Dr. D. A. GRIFFITHS (U.K.) subsequently confirmed this identification.

Since the systematic position of this species is complex, some clarification of the taxonomy is necessary, *Sancassania berlesei* (Michael, 1903) is an Astigmatid mite belonging to the family Acaridae. It was misidentified as *Tyroglyphus mycophagus* Megnin, 1874, by BERLESE (1891). In 1903, MICHAEL showed *Tyroglyphus mycophagus* Megnin to be a different species, being that figured by BERLESE in 1888 as *Tyroglyphus krameri*. MICHAEL then renamed *Tyroglyphus mycophagus sensu* BERLESE, 1891, *Tyroglyphus berlesei* Michael, 1903.

OUDEMANS (1916) erected the genus *Sancassania* based on free living hypopi and established *Sancassania chelone* Oudemans as the type species. BERLESE in 1923 transferred *Tyroglyphus berlesei* to a new genus, *Caloglyphus* and made *Caloglyphus berlesei* the type species. ZAKHVATKIN (1941) pointed out the probable synonymy of the genera *Sancassania* and *Caloglyphus*, but followed BERLESE's nomenclature because he believed the hypopial form precluded correct judgement of the systematic position. SAMŠINAK (1960) examined the type material of *Sancassania* Oudemans, 1916, in Leiden and found this to be synonymous with *Caloglyphus* Berlese, 1923. SAMŠINAK drew attention to the senior synonym of *Caloglyphus*, *Sancassania*, but

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this action remained generally unnoticed until recently (LINDQUIST, 1976). Since the type species of *Sancassania*, *S. chelone* Oudemans, is known only in the hypopial stage, HUGHES (1976) continued to use the name *Caloglyphus*. Although the hypopi of *Sancassania* and *Caloglyphus* are similar HUGHES maintained that the adults might have few taxonomic features in common, and for this reason she retained the name *Caloglyphus*. FAIN (1977) gave a detailed description of the hypopus of *Sancassania chelone* based on OUDEMANS' type material. He was unable to distinguish this from hypopi of *Caloglyphus*, and accepts SAMŠINAK's (1960) synonymy.

We have chosen to follow SAMŠINAK (1960) and use *Sancassania*, the senior synonym of *Caloglyphus*.

Cultures of *S. berlesei* were maintained in the laboratory, and while being used for biological studies varying male forms were observed. Two male types, or polymorphs, were readily differentiated by the form of the third pair of legs. One type possessed a grossly thickened third pair of legs which terminate in a stout apophysis. These males occur infrequently, most often occurring in low density cultures. The other type has a slender third pair of legs similar to the fourth pair of legs of all *S. berlesei* males.

The research was initiated in order to gain insight into the general biology of *S. berlesei*, the reasons for the occurrence of polymorphic males, and in particular to investigate the behaviour and selective advantage of these male types.

■ *Feeding Habits.*

The range of food sources reported show *S. berlesei* to be a polyphagous feeder, accepting all kinds of deteriorating plant and animal material. *S. berlesei* occurs in damp situations such as poorly stored food products with a high moisture content, and barnyard or poultry litter. In food stores, *S. berlesei* has been occasionally found on damp mouldy wheat, copra, linseed and groundnuts (peanuts) which have been kept under extremely damp conditions (HUGHES, 1961). It has been reported on rotting potato tubers and mushrooms in Italy (ZAKHVATKIN, 1941). WOMERSLEY (1941) recorded *S. berlesei* on yams from China and in copra from the Pacific Islands. In recent years *S. berlesei* often has been found in large numbers in the deep litter of poultry runs (HUGHES, 1961, JOHNSTON, 1966, BRADY, 1970). This species has recently been found damaging and tainting pigmeal to the extent that the animals would not eat the grain. Also, large numbers of this mite have been found in lucerne hay which had been prematurely baled and consequently had a high moisture content. *S. berlesei* is sometimes found in insect cultures and will feed on the eggs and larvae (HUGHES, 1961).

■ *Life History.*

The life cycle of *S. berlesei* consists of the egg, three active immature stages (larva, protonymph and tritonymph), and the adult. A resistant hypopus may form between the protonymphal and tritonymphal stages under adverse conditions. Prior to moulting to the next developmental stage, each immature mite undergoes a quiescent period. Unlike many other mites, *S. berlesei* cannot reproduce parthenogenetically, and mates immediately after its final moult.

■ *Developmental Times.*

To facilitate later experimental work, it was necessary to have some idea of the time *S. berlesei* spent in each active and quiescent immature stage, under the conditions used throughout this study.

RODRIGUEZ and STEPIEN (1973) presented the developmental times of *S. berlesei* reared on a xenic diet, at 92 % ± 3 % RH. Individual mites were held in separate rearing cells under subdued continuous light at 25°C. Observations were made twice daily (8 a.m. and 5 p.m.) on 50 specimens. Since *S. berlesei* is capable of going through one complete generation in a

matter of a few days, the twice daily observations made by RODRIGUEZ and STEPIEN (1973) were not frequent enough to accurately define the time spent in each developmental stage. In order to delineate more precisely these time intervals for mites raised on yeast pellets, an experiment was designed with observations every two hours.

Five eggs were collected within ten minutes of laying as they were laid, removed and placed in separate cells. Dry activated yeast was provided as a food source, and placed with mites in individual cells on a moist charcoal-plaster base (providing an approximate RH of 95 %). The cells were kept in semi-dark conditions in an incubator at 25°C except when observations were made in bright light at two hourly intervals. The results of this experiment are presented with those of RODRIGUEZ and STEPIEN in Table 1.

TABLE 1. — Developmental times of *S. berlesei* reared on a yeast diet [1] and on a xenic diet [2].

Developmental Stage	Time Spent in Each Stage in Hours at 25°C	
	Yeast Diet n = 5	Xenic Diet n = 50
Egg	55.5	58.0
Larvae	26.8	32.0
Larval quiescence	11.0	17.3
Protonymph	21.5	16.1
Protonymphal quiescence	9.0	12.4
Tritonymp	22.0	40.5
Tritonymphal quiescence	13.0	17.0
TOTAL hours to maturity	158.8	193.3
Pre-ovipositional period	22.0	36.0

1. Activated yeast pellets placed on moist substrate.
2. Xenic diet as used by Rodriguez and Stepien (1973) is an agar based, chemically defined diet (Rodriguez, 1972).

Comparison of developmental times showed that for all stages, except the protonymph, development of mites reared on the yeast diet was more rapid than those reared on the xenic diet. The greatest difference appears in the active tritonymph period where on the yeast diet it was 22 hrs and on the xenic diet it was 40.5 hrs. However, KANUNGO (1969, 1971) found the total duration of the tritonymph stage reared on dried yeast at 25°C and 95 % RH was ca 45 hrs of which 25-30 hrs were spent in an active feeding phase and 15-20 hrs in a quiescent period. For all the other developmental stages the difference on yeast and xenic diets is only a few hours, and is not significant.

The total number of hours to maturity on the yeast diet was 158.8, 34.5 hrs less than on the xenic diet. The length of time for one complete generation (egg to egg) for mites reared on the yeast diet was 180 hrs, while for mites reared on the xenic diet it was 230 hrs. This means that *S. berlesei* reared on yeast are producing eggs two days before those mites reared on the xenic diet. It is possible that some explanation of this time discrepancy can be given by reference to the period in which no observations were carried out in the earlier research by RODRIGUEZ and STEPIEN (1973), and the small number of organisms used in the present study.

■ *Description and Biology of Immature Stages.*

The first eggs are laid within 24 hrs of mating. *S. berlesei* is oviparous and the maximum daily egg production of a single female has been reported to be from 145 (RODRIGUEZ and STEPIEN, 1973) to 213 (HUGHES, 1961). We found after a single mating that the mean number of eggs laid was 260 (TIMMS *et al.* unpublished ; n = 20). The eggs are small (140 µm long) with a smooth chorion and lack pigmentation giving the eggs a translucent appearance.

Incubation lasts approximately 60 hrs at 25°C, accounting for over 30 % of the pre-imaginal developmental time. The larva possesses three pairs of legs while the other immature stages possess four pairs. The larval stage has a pair of special temporary structures of unknown function known as coxal rods or " bruststiele ". These rods arise from the coxal region of the first pair of legs, are hollow and distally enlarged. The larva lacks the leaf-shaped setae of the other stages on the apical area of the first and second pair of legs. In the larva the propodosoma and hysterosoma are almost equal in size, and the length of the idiosoma in total varies from 180 µm to 300 µm.

After a period of activity the larva becomes passive, and from this resting stage emerges the protonymph. The protonymph has four pairs of well developed legs, is the first stage to possess leaf-shaped setae on the forelegs, and lacks other typical larval features. The length of the idiosoma measures from 300 μm to 500 μm. The protonymph is characterized by the appearance of the rudiments of a genital opening with one pair of genital sense organs. From the resting protonymph emerges the tritonymph which is slightly larger than the protonymph, the length of the idiosoma varies from 400 μm to 700 μm. The tritonymph more closely resembles the adult by possessing a vestigial genital opening flanked by two pairs of genital sense organs, and a complete set of genital setae. RODRIGUEZ and STEPIEN (1973) claimed to be able to differentiate male and female tritonymphs by size, however in this study sexual differentiation of immature stages was not achieved. It was observed that at some time in the active tritonymphal stage there is a critical period, after which the male form becomes irreversible. Alteration of some environmental condition such as temperature, humidity, lack of food, etc., up to this critical period can change the form of the male.

Hypopus

Under adverse conditions there is a totally different form, the hypopus or deutonymph, which appears between the protonymphal and tritonymphal stages. The appearance of this optional hypopial stage is a characteristic feature of many astigmatid mite life cycles.

According to WALLACE (1960) there are three basic types of hypopi ranging from complete cyst-like forms to intermediate forms to highly mobile forms. The hypopus of *S. berlesei* is an active non-feeding, resistant stage.

Description

The hypopus is completely different in form to the other development stages in the life cycle (Fig. 1a and b). The hypopial idiosoma is

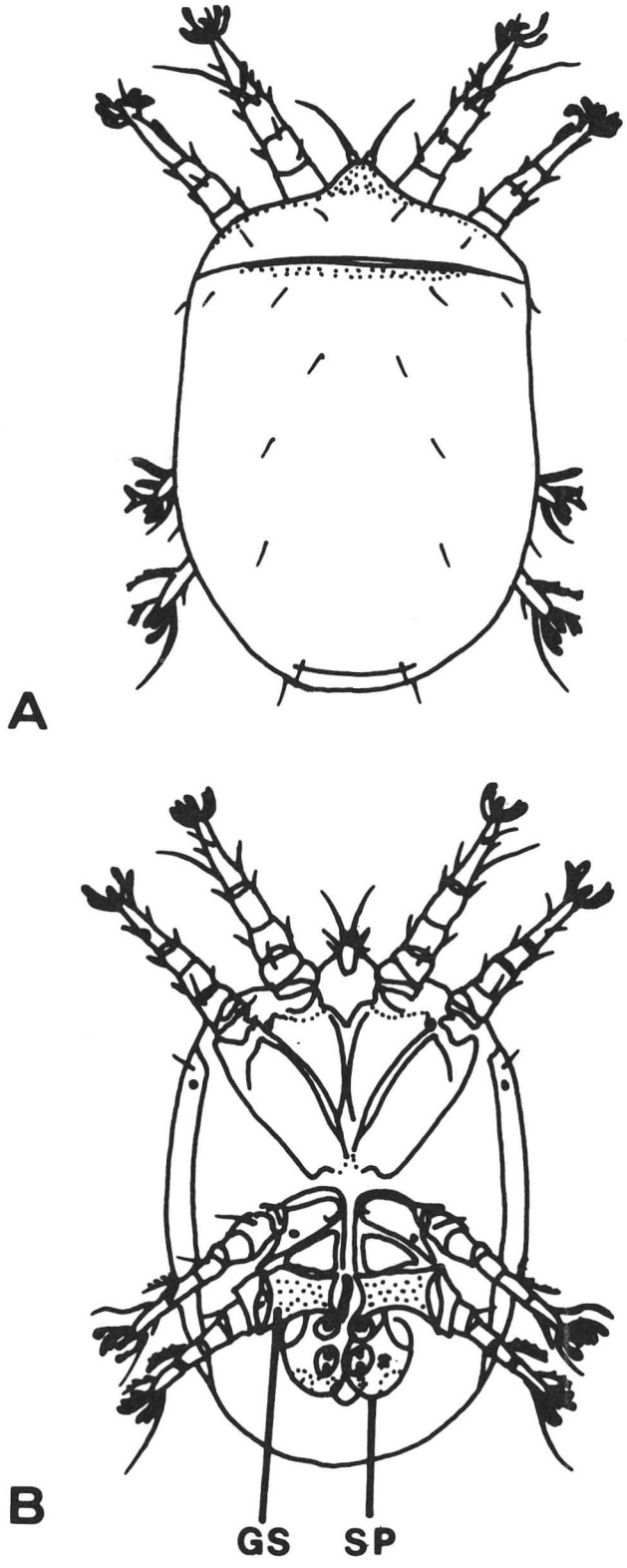

FIG. 1. *S. berlesei* dorsal (a) and ventral (b) views of hypopus ; genital shield (GS) and sucker plate (SP).

pinky-brown and varies in length from 250 μm to 350 μm. The propodosoma is almost triangular in shape and the hysterosoma is four to five times longer than the propodosoma. Ventrally the " sucker disc " is perforated by eight suckers with the central and anterior ones being of almost equal diameter. All four pairs of legs have well developed claws and pretarsi. When the hypopus is viewed from above, the greater part of the first and second pair of legs is visible, whereas only the tarsi and pretarsi of the third and fourth pair is visible.

Formation and Termination of Hypopi. The environmental factors inducing formation of the hypopus have been studied in many species. It has been speculated that environmental factors such as temperature, relative humidity, quality and quantity of food, overcrowding and waste product accumulation could act either directly or indirectly to stimulate hypopial formation. Apparently the factor or factors responsible for hypopial formation vary in different species, and have been discussed by WOODRING (1963), CHMIELEWSKI (1967), and KUO and NESBITT (1970). Termination of the hypopial stage has been shown to be influenced by a number of factors including temperature, humidity and nutritional changes in *S. mycophagus* (Megnin) (KUO and NESBITT, 1970).

S. berlesei hypopi developed when cultures were neglected and left to desiccate at room temperature. No further food or water was provided, and gradually a large amount of frass accumulated, adult mites died, and hypopi were found among the frass. These were collected and placed together with yeast in a cell with a moist charcoal-plaster substrate at 25°C. It was presumed these conditions would trigger development into tritonymphs.

Of 100 hypopi collected and provided with a humid environment and food, only 25 reached sexual maturity. There were seven females and 18 males, of these four were bimorphs and 14 were pleomorphs. This shows that both male and female *S. berlesei* have the faculty to become hypopi. Although a larger proportion of males became pleomorphs this could be an artifact of the small population rather than some property of the hypopial stage itself. A high proportion of hypopi (75 %) failed to reach adulthood. This suggests the triggering for the completion of the life cycle is rather more complex than was demonstrated by this simple experiment. KUO and NESBITT (1970) found not all hypopi moult to the successive stage. The hypopus must receive the moulting stimulus before a certain " critical period " is reached, after which the stimulus is not effective and the hypopus dies. It is possible that some of the 75 hypopi which failed to develop did not receive the moulting stimulus in time, or that the moulting stimulus itself was not strong enough.

Dispersal. The hypopi are the main dispersal phase of *S. berlesei.* Hypopi attach themselves to the bodies of larvae or adult insects by their " sucker disc " and may be carried to new habitats. This passive form of migration, utilizing insects as carriers, is known as phoresy. *S. berlesei* has been reported in association with many stored product insects, particularly *Tenebrio molitor* L. (HUGHES, 1961) and also with various Scarabaeidae. Hypopi were found on the dorsal surface of the abdomen and under the wings of the beetles *Oryctes nasicornis* L. and *Polyphylla fullo* L. (ZAKHVATKIN, 1941). WOMERSLEY (1941) recorded it in association with the termite *Eutermes exitiosis* Hill.

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